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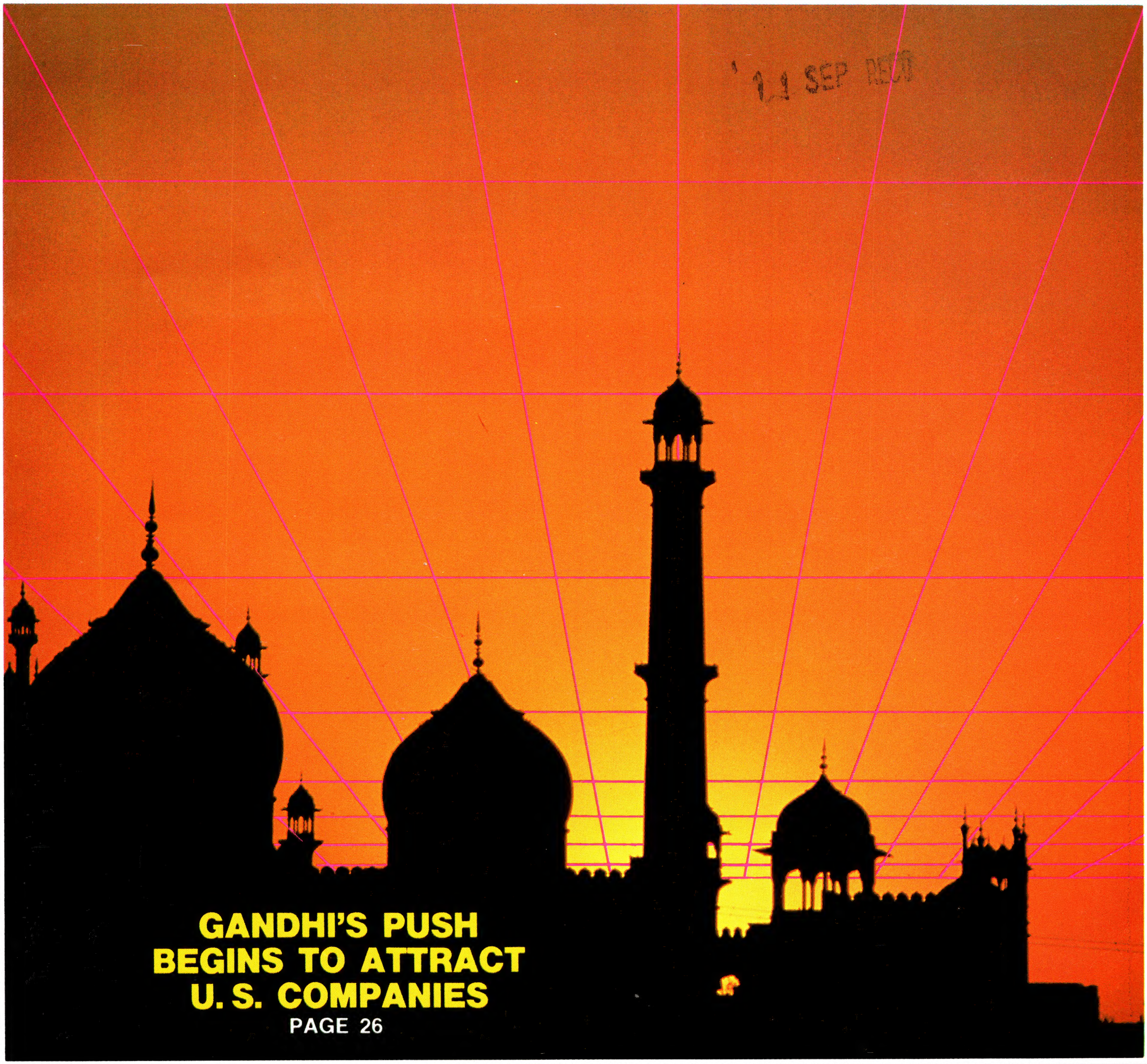
THE WORLDWIDE TECHNOLOGY WEEKLY
SEPTEMBER 2, 1985

INDIA STRIVES TO JOIN THE HIGH-TECH WORLD



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GANDHI'S PUSH BEGINS TO ATTRACT U. S. COMPANIES
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BIGGER BAG OF TECHNOLOGY SHARPENS MACHINE VISION/41

UNIX IS A TRADEMARK OF AT&T BELL LABORATORIES. SERIES 32000 IS A TRADEMARK OF NATIONAL SEMICONDUCTOR CORPORATION.

"What's on your mind, Jerry?"

"I'm worried. Marketing wants us to develop a UNIX based system that's way ahead of everyone else."

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"And, as usual, they need it yesterday."

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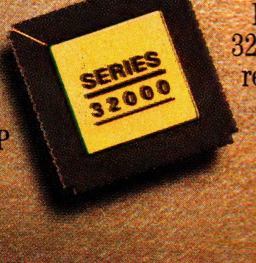

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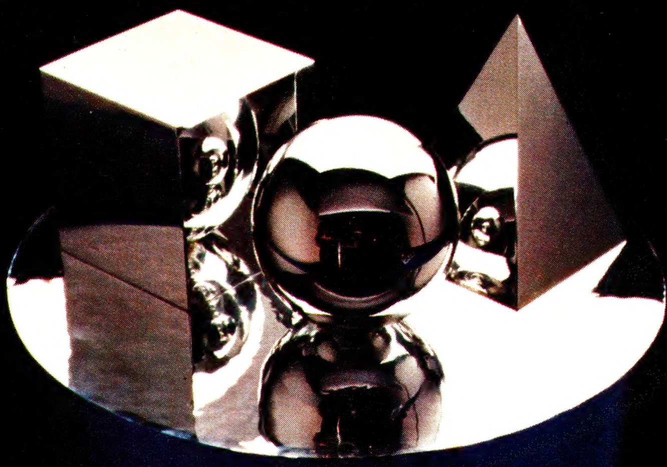

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Electronics

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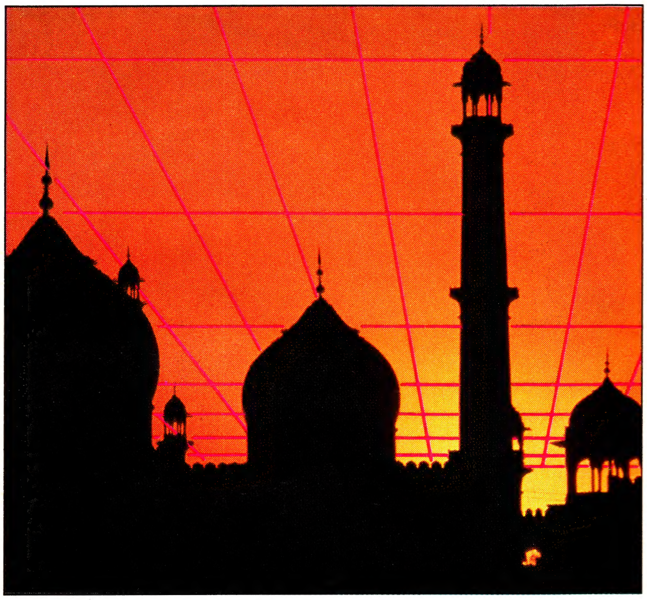

COVER: India strives to join high-tech world, 26
Prime Minister Rajiv Gandhi wants to push his developing nation into the computer age by liberalizing its tightly controlled computer and electronics industries. A number of companies in the U. S. and Europe like the changes and are tying up with Indian companies
Cover photo by Thomas Rampy, the Image Bank

Optical fiber makes its move in datacom, 30
Despite such advantages as speed and immunity to electromagnetic interference, lightwave communications hasn't been used much to link computers. Its only big success has been in telephone lines. But vendors of fiber-optic systems expect to carve major inroads in data communications

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8.

Meets high technical requirements made nowadays on dual-in-line relays

7.

Low power consumtion

Extremely low power consumtion of only 75 mW without fixed polarity of current means a lower circuit power demand and less heat dissipation.

6.

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5.

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4.

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3.

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2.

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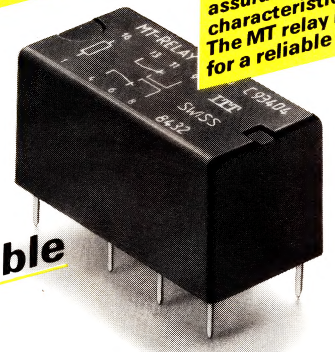

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PUBLISHER'S LETTER

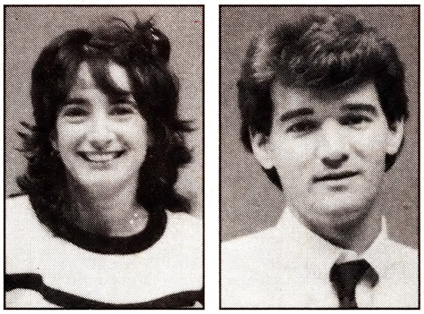
Making big news of its own these days is our Washington bureau. After becoming a mother for the first time this spring, Karen Berney has returned to duty covering Capitol Hill and the communications beat. And George Leopold has moved to Washington from our New York bureau. He is covering the Pentagon as well as industry in Virginia, North Carolina, Georgia, and Florida.

Karen is a Navy brat, never staying in one place for too long. "I satisfied my passion for traveling with a final one-year spree: all over Asia—from Nepal to Japan and everything in between—prior to joining *Electronics,*" she says. "Now I've settled down and made Washington my home with my husband and baby daughter, Jonna Elinor McKone."

George's route to the capital was a bit more direct, from his hometown of Appleton, Wis., via the University of Wisconsin, to Columbia University's Graduate School of Journalism for a master's degree. He started working at *Electronics* upon graduation in 1984. After writing new-product reports for a time, George covered the New York metropolitan area before we promoted him to Washington. He and his wife, Ellen Seefelt, an artist who specializes in water colors, live in suburban Maryland.

Although we maintain the most extensive system of domestic and overseas bureaus of any publication covering the electronics industry, we do occasionally have to call on outside help to cover an important story in an area of the globe that we don't routinely staff. This week's cover story (p. 26) on India's high-technology drive is a case in point: it was reported and written by Vyvyan Tenorio, a correspondent for McGraw-Hill's World News Service.

Tenorio is, at 30, a young veteran of the news business who knows her way around Asia. A native of the Philippines and a naturalized American citizen, her work has appeared in such diverse publications as *The Los Angeles Times*, the Asian *Wall Street Journal*, and *Institutional Investor* magazine. She has also worked for an economics news service affiliated with United Press International. When stationed in Hong Kong with her husband Matt Miller, who works for the Dow Jones News Service, she traveled extensively throughout China on assignment.



CAPITAL CREW. Karen Berney and George Leopold cover Washington.

That rich and varied background comes in handy when Vyvyan works on any story, particularly one about India, with its complex bureaucracy. We think you'll agree that she more than does justice to that side of the story as well as the technological aspects.

Laurence Altman

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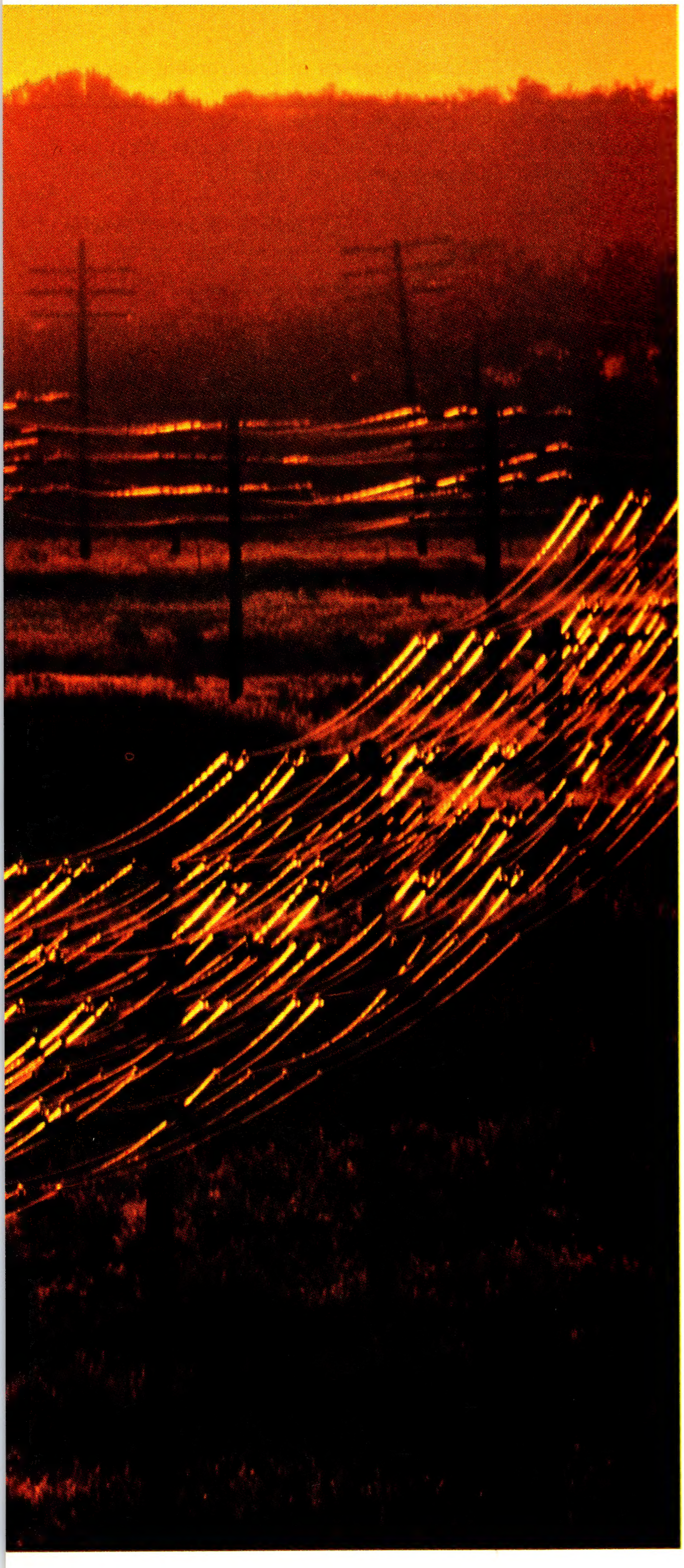

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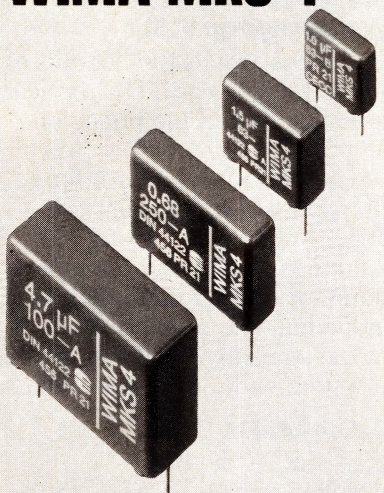

* CECC = Cenelec Electronic Components Committee of the European Committee for Electrotechnical Standardization

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MEETINGS

ICCD '85: International Conference on Computer Design, IEEE (ICCD '85, P. O. Box 639, Silver Spring, Md. 20901), Rye Town Hilton, Port Chester, N. Y., Oct. 7-10.

Semiconductor Industry Conference: An Industry in Transition, Dataquest Inc. (1290 Ridder Park Dr., San Jose, Calif. 95131), Sheraton El Conquistador, Tucson, Ariz., Oct. 14-16.

FODC-85: International Conference and Exhibition on Fiber Optics for the Developing Countries, IGI Consulting Inc. (214 Harvard Ave., Boston, Mass. 02134), CanKarjev Dom, Ljubljana, Yugoslavia, Oct. 14-18.

1985 Taiwan Electronics Show, China External Trade Development Council (201 Tunhwa N. Rd., Taipei, Taiwan 105, R. O. C.), CETDC's Sungshan Airport Exhibition Complex, Taipei, Oct. 14-20.

ADEE East '85: Automated Design and Engineering for Electronics Exposition and Conference, Cahners Exposition Group (Cahners Plaza, 1350 E. Touhy Ave., Des Plaines, Ill. 60018), Bayside Exposition Center, Boston, Oct. 15-17.

ISA/85, Instrument Society of America (67 Alexander Dr., Research Triangle Park, N. C. 27709), Civic Center, Philadelphia, Oct. 21-24.

International Business Show, BETA Exhibitions Ltd. (8 Southampton Pl., London WC1A 2EF, England), National Exhibition Centre, Birmingham, England, Oct. 21-25.

ISTFA/85: Eleventh Annual International Symposium for Testing & Failure Analysis, International Society for Testing and Failure Analysis (P. O. Box 4110, Torrance, Calif. 90510), Queen Mary Hotel, Long Beach, Calif. Oct. 21-25.

Satech '85: Systems and Applied Technology, Intertec Communications Inc. (2472 Eastman Ave., Ventura, Calif. 93003), O'Hare Expo Center, Chicago, Oct. 22-24.

Northcon/85, IEEE *et al.* (Electronic Conventions Management Inc., 8110 Airport Blvd., Los Angeles, Calif. 90045), Portland Coliseum, Portland, Ore., Oct. 22-24.

Worldcom-85: Fifth Multinational Conference on World Communications and Computers, International Council for Planning (P. O. Box 17392, Washington, D. C. 20041), Hyatt Regency Hotel, San Francisco, Oct. 22-26.

Telecommunications Demand Modeling Conference, Bell Communications Research (Alain de Fontenay, Marketing Planning Decision Technology Division, Bellcore, LCC 1B120, 290 W. Mt. Pleasant Ave., Livingston, N. J. 07039-2729), Hyatt Regency, New Orleans, Oct. 23-25.

Expert Systems in Government Symposium, IEEE and Mitre Corp. (Expert Systems Symposium, 1109 Spring St., Suite 300, Silver Spring, Md. 20910), Tyson's Westpark Hotel, McLean, Va., Oct. 23-25.

IEEE 1985 Symposium on Nuclear Power Systems, IEEE (Quadrex Corp., 1700 Dell Ave., Campbell, Calif. 95008), San Francisco, Oct. 23-25.

Communications Technology, Industrial and Trade Fairs International Ltd. (Radcliffe House, Blenheim Ct., Solihull, West Midlands B91 2BG, UK), Taj Mahal Hotel, Bombay, India, Oct. 26-28.

Europe's New Challenge: Emerging Business Opportunities Related to GaAs and the III-V Technologies, Horizon Associates and SRI International (Robert F. Dick, Horizon Associates, 2255-G Martin Ave., Santa Clara, Calif. 95050), Hotel Zurich, Zurich, Switzerland, Oct. 28.

Pacific Northwest Computer Graphics Conference, University of Oregon (333 Oregon Hall, Eugene, Ore. 97403-1217), Hilton Hotel, Eugene, Oct. 28-29.

Automation Means Business, Dataquest Inc. (1290 Ridder Park Dr., San Jose, Calif. 95131), Hyatt Regency, Chicago, Oct. 28-29.

Localnet '85: The Industry Show, Online Conferences Inc. (989 Avenue of the Americas, New York, N. Y. 10018), New York Hilton, New York, Oct. 28-30.

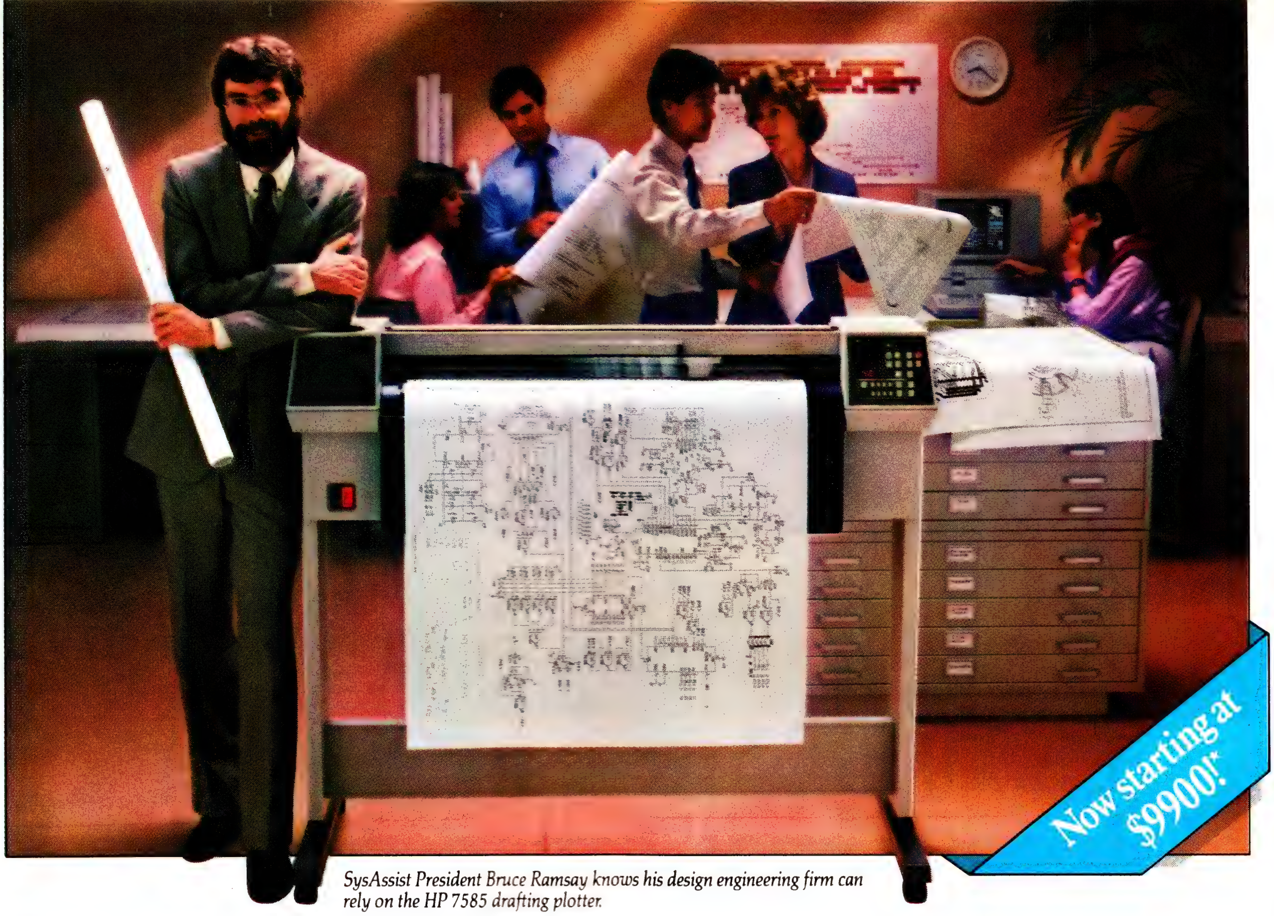
Cellular Communications '85, Online Conferences Inc. (989 Avenue of the Americas, New York, N. Y. 10018), New York Hilton, New York, Oct. 28-30.

DPMA Houston '85, Data Processing Management Association (505 Busse Hwy., Park Ridge, Ill. 60068-3191), Albert Thomas Hall, Houston, Oct. 28-30.

ATE Central '85, Morgan-Grampian Expositions Group, (1050 Commonwealth Ave., Boston, Mass. 02215), O'Hare Exposition Center, Rosemont, Ill., Oct. 28-31.

International Telemetering Conference, International Telemetering Committee (Darrel J. Gabel, U. S. Air Force, WSMC/RT, Vandenberg AFB, Calif. 93437), Riviera Hotel, Las Vegas, Oct. 28-31.

Systems 85, Munich Trade Fair Corp. (Kallman Associates, 5 Maple Ct., Ridgewood, N. J. 07450-4431), Munich Trade Fair Center, Munich, Oct. 28-Nov. 1.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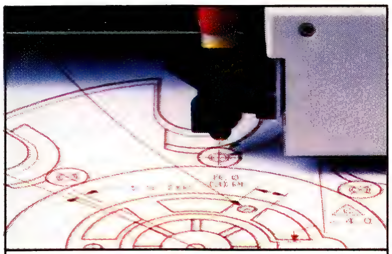

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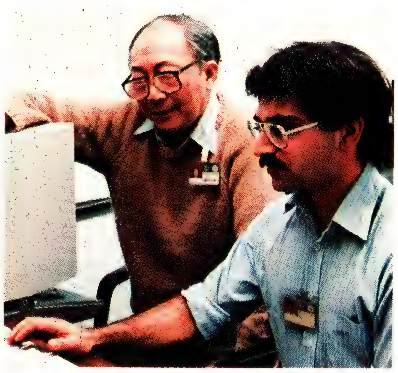

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ELECTRONICS NEWSLETTER

INTEL DESIGNS VLSI CONTROLLER CHIP FOR MAP

The equipment market that General Motors Corp.'s Manufacturing Automation Protocol aims to create has a billion-dollar potential, and Intel Corp. is positioning itself to take a solid share of it. Following up on a host of planned board-level and software products to support MAP, Intel is developing a very large-scale integrated-circuit controller chip that handles MAP connection functions. Similar to the company's 82586 Ethernet local-area-network controller chip and developed by the same design team, the new chip will be 30% more complex with over 100,000 active elements, says MAP product manager Michelle Ryder. Because of overlaps with the Ethernet controller design, about half the new chip is already debugged, says Ryder. First silicon is expected in the fourth quarter. ☐

FUJITSU LOOKS TO FAST 4-K GaAs CHIP TO IMPROVE SUPERCOMPUTERS

What Fujitsu Ltd. claims is the world's fastest low-energy-consuming 4-K gallium arsenide chip promises to help the Tokyo company build better supercomputers. The new device, disclosed in late August at the 17th Conference on Solid-State Devices and Materials held in Tokyo, was developed by researchers at Fujitsu Laboratories, Atsugi, and reportedly has an optimum address access of 1.7 ns and consumes 600 mW. Previously, the pacesetting 4-K GaAs memory came from Nippon Telegraph & Telephone Corp. It had a reported access time of 2 ns and used 900 mW of power. The Fujitsu chip's speed comes from a new process originally developed for a high-speed FET: a very thin film of aluminum nitride is laid atop the GaAs substrate, and silicon ions are implanted through the film onto the GaAs to form active regions. The result, says Masaaki Kobayashi, deputy general manager of the semiconductor division at Fujitsu Labs, is reduced effective distance between the aluminum nitride surface and the GaAs channels. ☐

CONNECTOR MAKER SAYS NEW PLATING MATERIAL WILL OUTPERFORM GOLD

Look for a new gold-substitute plating material that Robinson Nugent Inc., a New Albany, Ind., connector maker, says will outperform gold thickness for thickness. Called Robex, the new plating consists of a proprietary palladium-nickel alloy that the company claims overcomes the reliability concerns about porosity in earlier palladium-nickel-plating compositions. One of the keys to Robex's success is its use of a custom formulated plating bath that differs from the standard industry 80%-20% and 75%-25% palladium-nickel mixes, in addition to the use of additional ingredients in the bath that result in a highly ordered palladium-nickel crystal structure on the connector pin. ☐

NEW FUNDING COULD PULL ZYMOS OUT OF DOLDRUMS

Zymos Corp., a struggling maker of standard cells, got some needed capital last week when a venture capital partnership bought out its principal backer, itself in need of funds. In return for a controlling interest in Zymos, Hambrecht & Quist Inc., a venture capital company, and Penn Central Corp. agreed to invest $10 million. In doing so, they relieved Intermedics Inc., Angelton, Texas, of a $10 million obligation to Zymos and all its Zymos stock. Zymos shareholders must approve the deal, considered likely because Intermedics owns 47% of the stock. The Sunnyvale, Calif., company will use the money to support increased design activity on standard cells, including analog cells and peripheral cells for its Poach chip, the IBM PC AT motherboard on a chip [*Electronics*, July 1, 1985, p. 23]. Zymos used Poach to demonstrate its new 2-μm CMOS technology, but the chip garnered so much interest that Zymos will now offer it as a standard product. ☐

ELECTRONICS NEWSLETTER

PERSONAL COMPUTER SALES OUTLOOK STILL CLOUDY

Forecasts for the troubled microcomputer hardware market don't show an upturn yet. After picking up in June, retail activity in personal computers slumped last month, notes the latest survey by Infocorp. Unit sales dropped 15% from the June level. Dollar sales stayed relatively strong with just a 1% slip, however, because consumers are switching to higher-priced equipment, the research company says. Infocorp's monthly retail sales index shows that unit shipments are rated at 91, off from June's rating of 107 [*Electronics*, Aug. 26, 1985, p. 21]. ☐

IC SALES WON'T RETURN TO 1984 LEVELS UNTIL 1988, SAYS RESEARCHER

Worldwide sales of integrated circuits are unlikely to bounce back to 1984's record levels until 1988, concludes market researchers In-Stat Inc., Scottsdale, Ariz. In-Stat has revised downward its 1985 IC forecast to $16.675 billion, an 18.9% drop from the $20.568 billion sold in 1984. Earlier this summer, In-Stat had forecast a 17.4% drop for the year. But IC sales were lower in this year's second quarter than estimated earlier. IC dollar shipments were down 9.4%, rather than the 8.6% In-Stat had expected. In the current, third quarter, In-Stat predicts, IC sales will slide another 8.5% from the second-quarter figure. In-Stat projects a slight improvement in the final three months of 1985, with revenue rising 4%, but no widespread industry recovery is expected. In fact, In-Stat has figured a general economic recession into the 3.3% decline in IC sales it is forecasting for 1986. ☐

32-BIT CMOS MICROPROCESSOR SLICE RUNS AT BIPOLAR SPEED

Adding to the threat that standard cells pose to gate arrays, which themselves succeeded full-custom chips in the application-specific integrated-circuit market, Waferscale Integration Inc., Fremont, Calif., has developed a CMOS 32-bit microprocessor slice. Waferscale says that the WS59032, combines bipolar performance with the low-power advantage of CMOS and that its flexible architecture and microcode mean that it can be configured to the user's precise requirements. The company says the chip is aimed at quick design of systems on a chip using standard-cell libraries and that a customer should be able to implement a design in 15 weeks. ☐

VALID LOGIC MAKES BID TO CATCH INDUSTRY LEADERS IN CAE MARKET

Trying to catch up in the market for computer-aided-engineering work stations, Valid Logic Systems Inc. last week introduced two stations and products to speed up graphics layout and logic simulation. Valid, which trails Daisy Systems Corp., Mountain View, Calif., and Mentor Graphics Corp., Beaverton, Ore., in work-station sales, now offers a work station based on an IBM Corp. Personal Computer AT that includes an extra board with a 32-bit microprocessor running Unix System V. Thus users can move between Unix and IBM's PC-DOS operating system. The San Jose, Calif., company also brought out an analog design station with its own software-based instruments—an oscilloscope, a digital voltmeter, a function generator and a network analyzer—and will generate a netlist from a schematic design.

Valid has a new 68020-based graphics accelerator that it says cuts layout time thirtyfold, and a logic simulator with a smart compiler that can recompile drawings a page at a time and cut compile time as much as tenfold. The graphics accelerator will cost $10,000 as an upgrade, but will be a standard part of future stations, as will the logic simulator. The AT-based station will cost $15,000 to add on to an existing AT, or up to $35,000 with a top-of-the-line IBM GX graphics display. The analog software costs $22,000. ☐

SIEMENS

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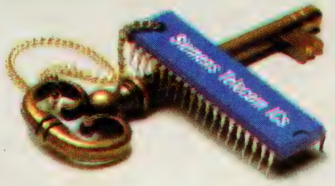

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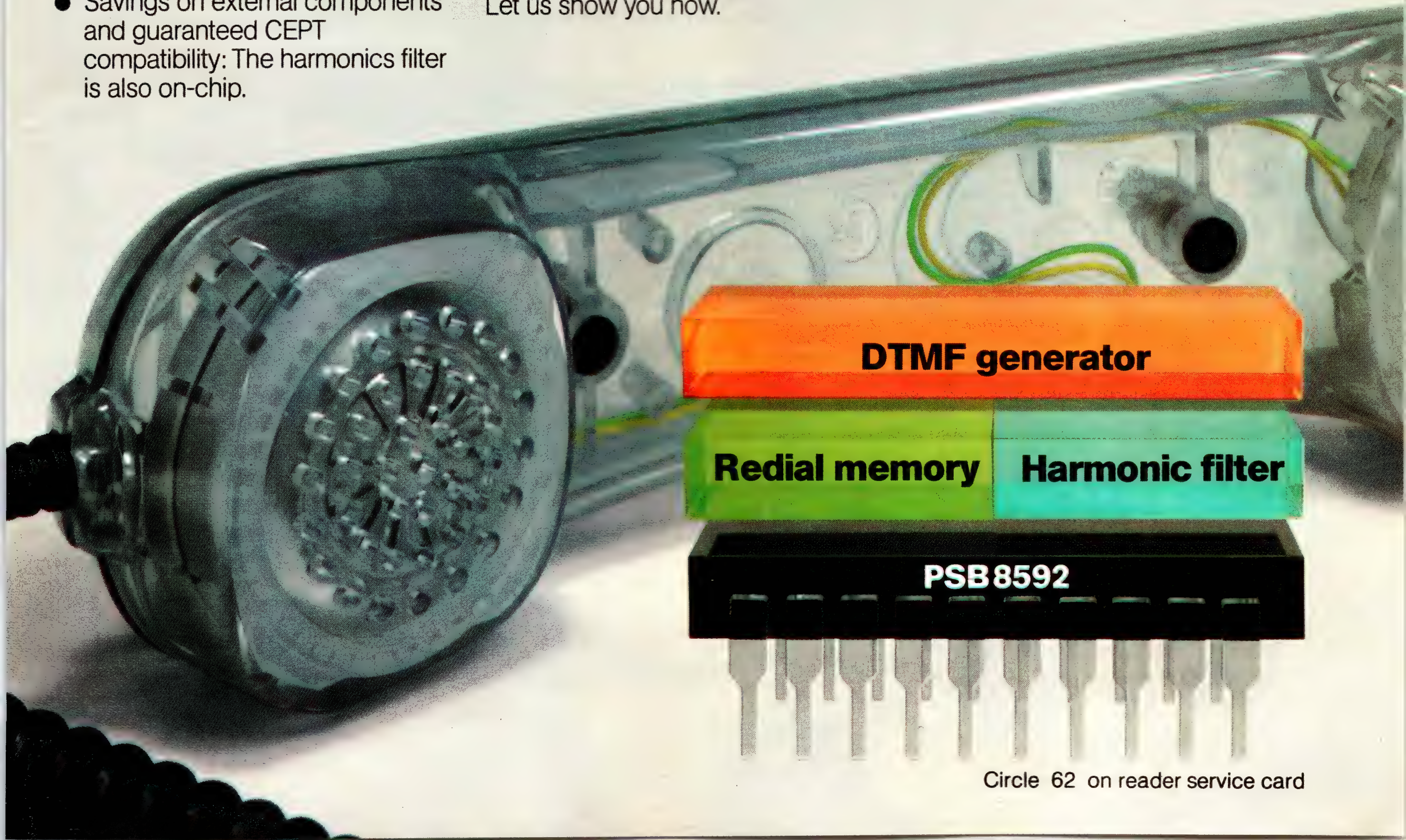
The key to communication systems



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Electronics

HONEYWELL BUILDS HARDWARE FOR COMPUTER SECURITY

MONITOR SUBSYSTEM THWARTS TROJAN-HORSE ATTACKS

MINNEAPOLIS

Honeywell Inc. is about to build a prototype of what it claims will be the first hardware-intensive approach to computer security. The project, supported by the Defense Department, aims to build a computer that will surpass A1, the DOD's highest level of computer-security classification.

The effort's goal is to develop subsystem hardware that will prevent breaches of security—including the broadest class of leaks, Trojan Horse attacks. A Trojan Horse program combines an innocent visible function with a concealed function used to gain unauthorized access to restricted files.

The computer, dubbed the Secure Ada Target Machine, has been in the works for the past six years, says Earl Boebert, senior fellow at Honeywell Systems and Research Center. Behind the current hardware development is extensive theoretical work that helps builders of computers develop mathematical proofs of their machines' security.

DOD criteria formally specify performance levels for computer-access control, system-operator notification, data logging and storage, and security verification. Research conducted for the project to refine the mathematical analysis and proof of computer security is as significant as the machine itself, say developers at Honeywell's Secure Computing Technology Center, Minneapolis.

The work builds on secure systems efforts on Multics and Scomp computers at Honeywell and the Provably Secure Operating System at SRI International.

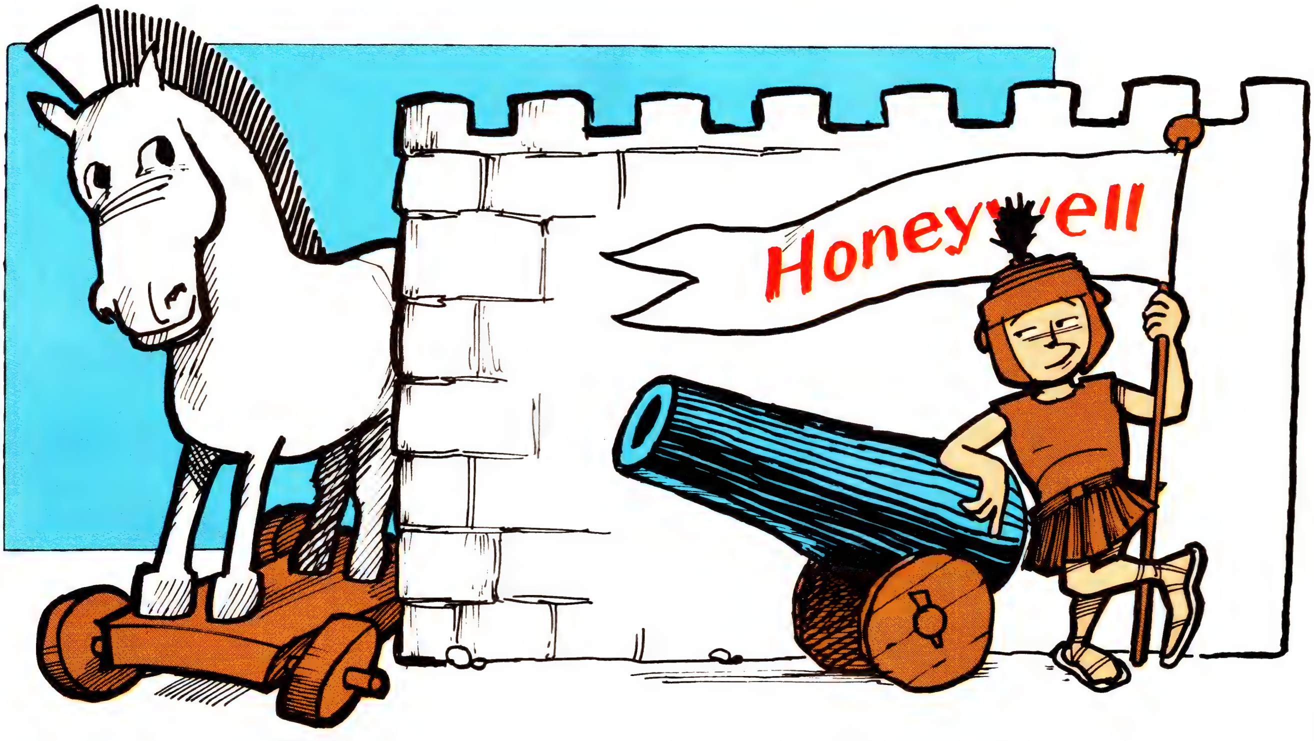
MONITOR SUBSYSTEM. In all secure-computer approaches, a reference-monitor subsystem is the "key to computer security at the A1 level or above," says Boebert. The subsystem controls users' access to the computer. In addition, it enforces priority levels, which restrict sensitive programs and data to authorized users.

The reference monitor is responsible for preventing Trojan Horse attacks. A Trojan Horse program depends on the fact that it will be invoked by a user with a high-level security authorization; the authorized user is aware only of using the program's legitimate function. But while that function is executing, the entire Trojan Horse program acquires authorization at the security level of this user. This authorization allows the hostile program's hidden function to read data from restricted files.

BLOCKING THE ATTACK. The Trojan Horse program then attempts to write that sensitive data into a low-security file that the attacking user can access. This is where Honeywell's reference monitor blocks the attack: all data passing to and from stored files must pass through the monitor. The monitor uses segmented-addressing techniques and access-mode fields to detect and prevent such data transfers.

The reference monitor subsystem will reside in a security-kernel subsystem. The ultimate goal is to put the security kernel on one chip, says Boebert.

Honeywell is using its 32-bit DPS-6 minicomputer as the baseline hardware for the project. But the security system will be housed in a coprocessor, indepen-



dent of the central processing unit. Performance of the user's application program thus proceeds unimpeded by the security subsystem.

Previous computer security approaches have involved few if any hardware modifications. Specialized hardware was considered more costly to develop and build than it was worth in terms of improved security. The usual tack is to design secure operating-system software and install it on a vulnerable computer. "One of the advantages of building a secure machine [from scratch] is that you have many more options on what you can audit and record," Boebert points out.

RIGOROUS PROOFS. "The weakest points of the previous efforts were in the area of assurance and proof," says Boebert. Most computer-security systems remain foolproof right up until the time they are compromised, as Boebert and colleagues Richard Kain and William Young remarked in a recent paper. Until mathematically rigorous proofs of computer security came along there was no way of predicting whether such a breach could be avoided, they say.

The Honeywell team's intellectual framework uses mathematical models to analyze computer security. They liken it to steps in the design of an airplane, where each level of design contains progressively more detailed and less ambiguous representations of the processes occurring within the machine. Rigorous proof of security is far simpler at high levels of abstraction than it is for proofs, attempted in earlier work, operating at the most detailed level of a system specification.

With the multilevel security approach, proof at the highest level is followed by demonstration that each succeeding lower level correctly implements descriptions used at higher levels. Software constructs that model a computer's internal mechanisms aid in this design breakdown. *–Alexander Wolfe*

PACKAGING

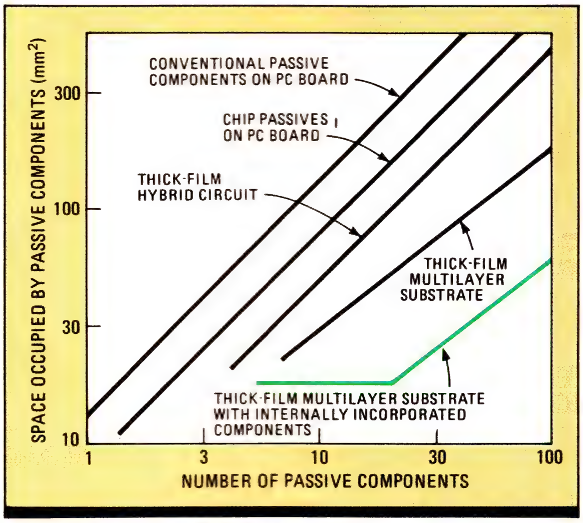
NEC LEARNS HOW TO BUILD PASSIVES IN SUBSTRATES

KAWASAKI, JAPAN

NEC Corp. has developed ceramics with which it can stuff more circuitry into less space. The materials make it possible to build passive components inside multilayer substrates, NEC says.

Developed by engineers at the company's Fundamental Research Laboratories in Kawasaki and the Circuit Components Division in Sagamihara, the ceramics have lower firing temperatures than conventional substrate ceramics. Lower firing temperatures permit NEC to use commercially available resistive and conductive inks for implementing the components economically.

For passive-component density, multilayer substrates have already surpassed single-layer hybrid circuits with thick-film interconnections. The ability to build internal components is another big stride for miniaturization (see figure). Passive-component density can be three times that of standard multilayer ceramic circuits for substrates with over 30 internal passive components.



HIDDEN PASSIVES. Building passive components into a ceramic substrate nets NEC a significant gain in circuit density.

NEC has fabricated a number of experimental circuits to demonstrate the process. Among them are a voltage-controlled oscillator, active filters, a 128-K-byte memory with 18 dynamic random-access-memory chips, a personal-computer interface for a cassette-tape recorder, a data-recorder amplifier, and three cards for a frequency counter: a light-emitting-diode display panel, a time base, and a high-frequency amplifier. Company sources are reluctant to discuss commercial products but indicate that custom products should be in production within a year or two.

MULTILAYER PROCESSING. The technology for fabricating these circuits is similar to that used for proven multilayer ceramic substrates. The individual layers in multilayer boards are so-called green sheets of unfired ceramic 80-μm thick—about the thickness of a sheet of paper—upon which conductor, resistor, and capacitor patterns are printed. More than one layer can be processed at a time, so fabrication time for multiple layers is no longer than for one layer.

The completed layers are stacked like sheets of paper; a single firing process completes the substrate. The process is economical for substrates with 10 to 50 layers. The substrate-fabrication process contrasts with that for a multilayer integrated circuit, whose layers are fabricated one after the next atop each other and whose fabrication time is proportional to the number of layers.

The ceramic for the internal-component substrates is a mix of alumina and lead borosilicate glass that can be fired below 900°C. The firing conditions are matched to the resistive paste, a ruthenium oxide type. The conductive paste is silver or silver palladium.

High-value capacitors (over 1,000 pF) require 50-μm-thick ceramic sheets with a high dielectric constant as the dielectric rather than the somewhat thicker standard green sheets, which are adequate for low-value capacitors (less than 100 pF). The thinner sheets are mixtures of lead iron tungstate, lead iron niobate, and lead zinc niobate compounds.

The experimental voltage-controlled oscillator, though not a particularly common circuit type, showcases NEC's ability to fabricate a complete repertoire of passive components, including high- and low-value capacitors, resistors, and low-inductance spiral coils. Moreover, the oscillator shows that the values of these components remain stable over long periods and through changes in temperature and voltage.

The DRAM circuits, an application closer to the mainstream, cram 128-K bytes into 42 by 46 mm—less than half the area of a standard printed-circuit board with the same number of memory chips. The 19-layer circuits have one bypass capacitor and 24 damping resistors internally, with nine flatpack-housed 64-K DRAMs on each substrate surface.

NEC mounted an additional 12 chip capacitors on the card's surface because it is not yet possible to build internal parts of sufficient capacitance without degrading other characteristics. Crosstalk between signal lines is kept to the relatively low value of 3%, compared with about 12% for standard pc boards, thanks to the circuit's internally mounted damping resistors.

NEC engineers have put four RAM circuits on a PC-9801 board with RAM-control and -driver circuits. The result is a 512-K-byte board the same size (150 by 170 mm) as NEC's standard 256-K-byte board. *–Charles L. Cohen*

COMPANIES

MOSTEK TOP SPOT LURES FIEBIGER FROM MOTOROLA

CARROLLTON, TEXAS

Shaky Mostek Corp. last week brought in a highly regarded semiconductor executive to pilot it back to profitability. With a signing bonus and pay incentives reportedly equal to those of top-round draft choices in professional sports, the troubled Carrollton company lured 43-year-old James R. Fiebiger away from his secure vice presidential post at Motorola Inc. to become its new president and chief executive officer.

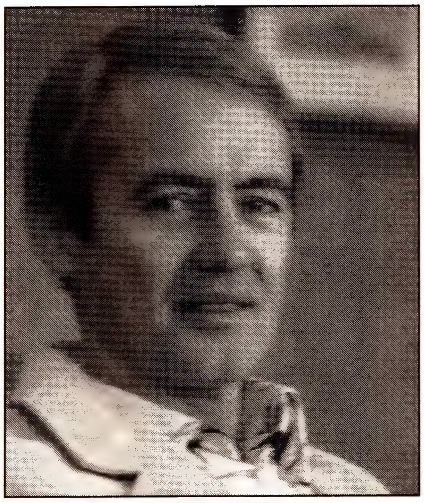
"It's a good opportunity to take something that needs a shot in the arm. I'm sure we can turn things around," states an eager Fiebiger. He started his semiconductor-engineering career in the Dallas area 15 years ago at rival Texas Instruments Inc. Fiebiger left TI in 1977 to lead Motorola's fledgling MOS operation in Austin, Texas, and worked his way up to senior vice president and assistant general manager of the Semiconductor Product Sector in Phoenix, Ariz. Though his departure was rumored for nearly a month, it stunned many of Fiebiger's closest Motorola associates.

NEW MARKET STRATEGIES. Mostek's parent, United Technologies Corp., Hartford, Conn., says Fiebiger is in Carrollton to do a lot more than just give Mostek a fighting chance again in the turbulent MOS-chip markets of the 1980s. He will also be there to help sort out Mostek's future. The conglomerate has to reevaluate its long-term plans in commodity semiconductor markets after the deficits at Mostek in recent years.

"Jim Fiebiger is fully conversant with the alternatives that we are reviewing and his goal is to assist us in evaluating these alternatives and in choosing the one that is best for UTC shareholders and helping us implement it," said a spokeswoman in a statement from the company's headquarters.

Mostek, the world's leading maker of dynamic random-access memories in the late 1970s, has had rough going almost from the time it was acquired by United Technologies in 1979. Buffeted by the boom-and-bust swings in the DRAM market, Mostek has hung on but remains unsuccessful in divesting itself of a heavy dependence on price-sensitive commodity memories.

The MOS maker already has lost nearly $100 million in 1985, laid off almost half its 9,800 employees, and seen a president forced out of office. Earlier this summer, United Technologies reassigned former president Harold L. Ergott Jr. to other duties in Hartford after the heavy losses set in and attempts to refocus Mostek's strategic direction faltered. Ergott resigned from United Technologies shortly thereafter.



MOSTEK'S MAN. James Fiebiger takes on a heady task: getting Mostek out of the red.

Most of Mostek's founders—who have since departed the company—are privately applauding the selection of a semiconductor executive. Fiebiger was chosen after an extensive industrywide search for a top name in the chip business. He reportedly received a multimillion-dollar package, including stock options if he succeeds in turning around the money loser and a "golden parachute" if he does not. United Technologies refuses comment on the package.

Still, much of Fiebiger's success hinges on United Technologies, says Harvey B. (Berry) Cash, an original employee and former vice president of marketing at Mostek. "I think L. J. [Sevin, also a Mostek founder] and all of us would say Fiebiger is a good guy, and all of us are parental enough to hope he can fix it because we don't like to see all of the negative things that are happening," Cash states.

A BIG TAB TO PICK UP. "Fiebiger was clearly the right-hand man when Al Stein [now chairman of VLSI Technology Inc., San Jose, Calif.] turned around Motorola semiconductors in the 1970s, and Fiebiger knows what to do," Cash says. "But the question is whether Hartford is willing to pick up the tab, because it is not going to be cheap."

Fiebiger's selection can be considered a coup for United Technologies, but many semiconductor-industry analysts are concerned about the long-term impact on Motorola. "Jim is highly regarded by his peers and subordinates. The bad part for Motorola is that there will clearly be some good people heading for Dallas," according to long-time industry analyst William I. Strauss, president of Forward Concepts Inc. in Tempe, Ariz. "I think Motorola won't scream too loudly about losing some people in the short-term. But it could end up being a negative." *–J. Robert Lineback*

SOFTWARE

SUN-AT&T DEAL COULD RESULT IN UNIX STANDARD

MOUNTAIN VIEW, CALIF.

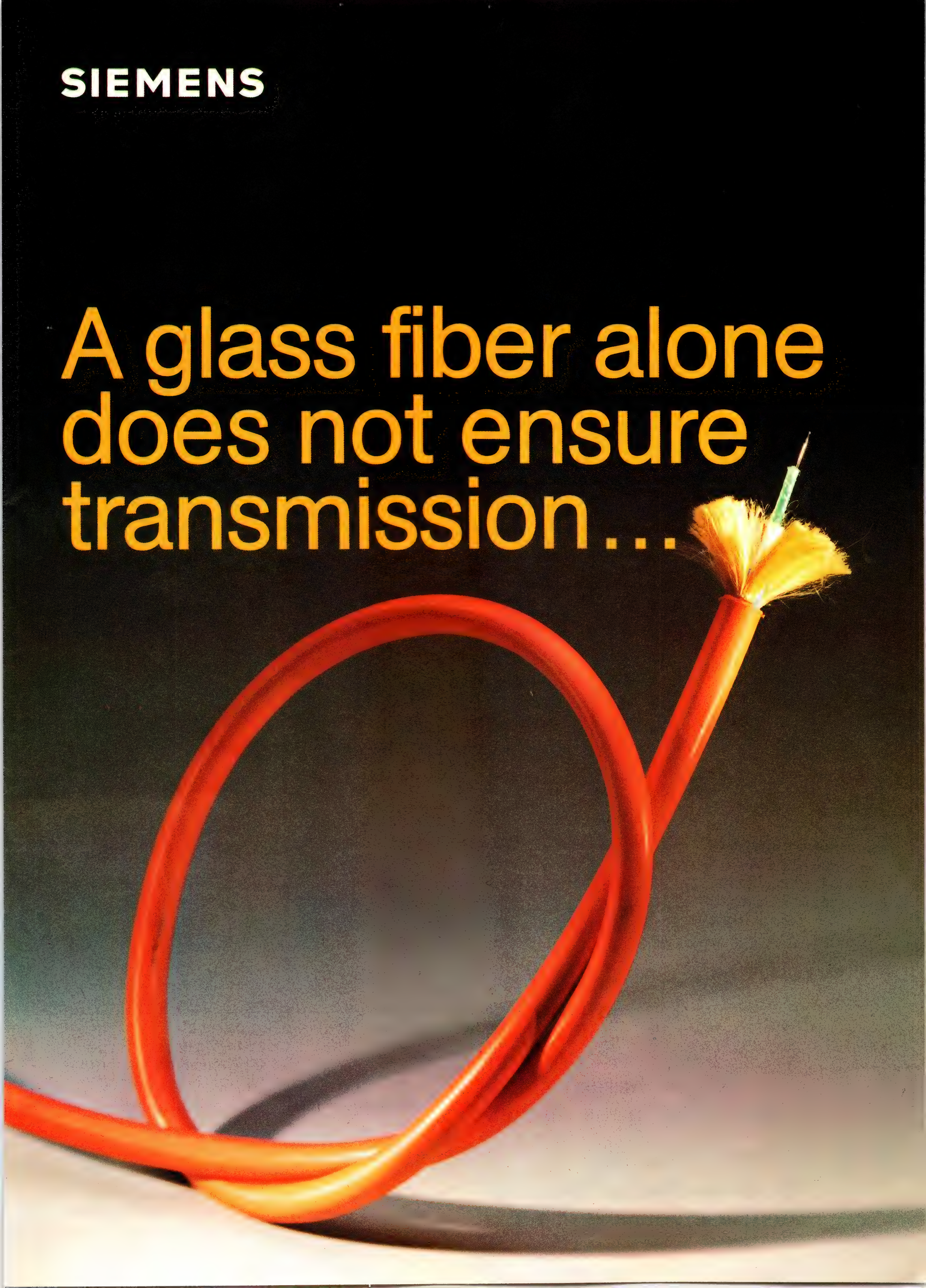
Sun Microsystems Inc. and AT&T Co.'s Computer Systems Division have signed a technology agreement that could end the battle over Unix standards. Sun, whose Unix 4.2bsd-based work stations have found favor in the engineering and scientific community, will merge its version with AT&T's Unix System V into an enhanced operating system that both hope will become the Unix standard.

The effort calls on Sun to make more than 300 utility commands converge. The new version will allow users to run applications for either 4.2bsd or System V on their existing hardware.

No money was exchanged under the terms of the agreement, according to Bernard J. Lacroute, executive vice president and general manager of the Mountain View, Calif., work-station maker. Instead, he says, Sun will share technology with AT&T and have access to early versions of its unreleased products, and the companies will jointly plan future features of Unix.

Sun's help was welcome, adds Roland Pampel, vice president of software for AT&T's Computer Systems Division in Morristown, N. J. "Consolidating the technical community is an important step in establishing Unix System V as the standard operating system for all computers, from micros to mainframes."

MISSING LINK. The enhanced System V—yet unnamed—will have the advanced networking capabilities of Unix 4.2bsd, whose main designer was Sun's vice president of research and development, Bill Joy. Joy says the convergence will be the missing link between the technical community and commercial areas where System V was targeted.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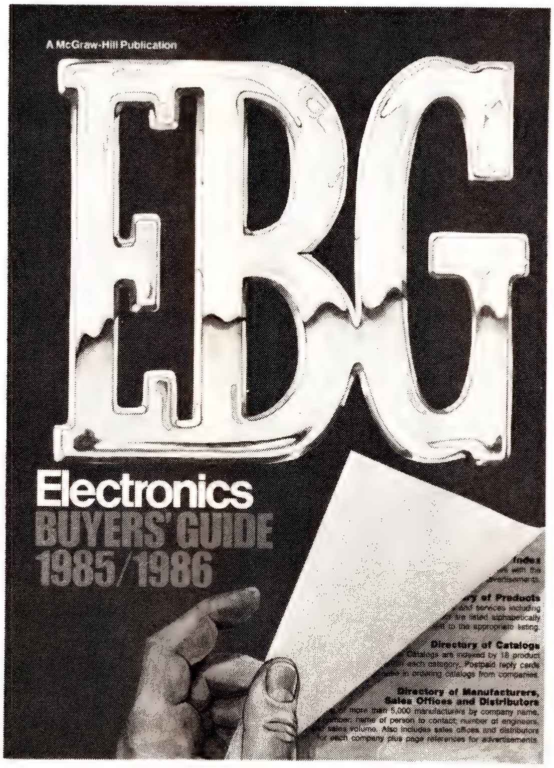
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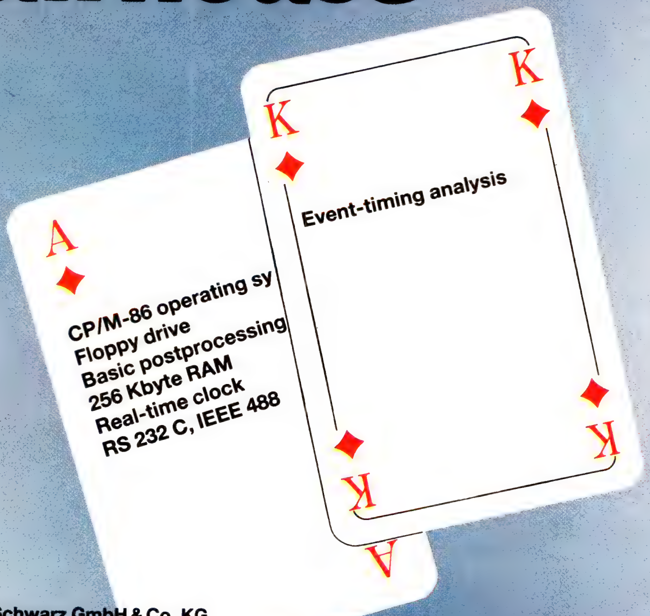

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"It's the needs of the market converging to a single base," says Joy of the agreement. "We [AT&T and Sun] have been heading apart, there's no question. Now we're headed back together."

First fruits of the agreement will be seen at Uniforum in Anaheim, Calif., in February 1986. Sun will display prototypes of its work stations running System V applications. It will also exhibit a prototype of its Network File System, which allows machines running the current System V to communicate transparently with 4.2-based machines.

Lacroute has "no good answer" about when products based on the converged operating system will be commercially available. "Some technical issues are involved, relating to new versions of System V from AT&T," he says. "We expect to have a product anywhere from 12 to 24 months from now, hopefully closer to 12 than to 24."

The new version will be available in much the same way it is now—through AT&T, for companies that want to adapt the system to their machines, or from Sun itself if the user has already purchased a Unix license from AT&T.

"Direct changes to the operating system will be as few as possible, and after long consideration and consultation with groups such as IEEE," says Joy. "We want to stabilize it first." AT&T is considering such changes as supporting Ada, the Department of Defense programming language, and Open Systems Interconnect protocols. At present, Sun uses the Transmission Control Protocol/Internet Protocol. *–Denise Caruso*

IC TESTING

NEW WAY TO TEST CHIPS USES VOLTAGE CONTRAST

OTTAWA, ONTARIO

Voltage-contrast testing, a technique for observing the internal workings of an integrated circuit by bombarding it with an electron beam, is producing impressive experimental test results in rapid detection of IC problems, according to engineers and scientists at Bell-Northern Research, Northern Telecom Inc.'s advanced research laboratory.

Considered experimental a few years ago, voltage-contrast methods appear ready to make a major contribution to the development, debugging, and testing of future submicron-geometry ICs, say industry sources. Chips with geometries near 1 μm are already in limited production at some semiconductor houses, and IC researchers are searching for the tools to build submicron ICs, the expected grandchildren of the standard 3-μm parts now being produced.

Breaking the 1-μm barrier is bound to pay off with dramatically faster circuits, but placing mechanical probes on conductors that small will be difficult if not impossible to do routinely. By avoiding the problems, voltage-contrast techniques will thus become vital to test engineers working with such circuits.

Voltage-contrast testing uses a modified scanning electron microscope as a strobe light. By coordinating the beam's strobe rate with the clock signals in an energized device, it is possible to form a logic-state map superimposed on the IC image. Differing voltages appear as contrasting areas of light and dark on the chip's surface. The noncontact, nonloading imaging process makes it possible to observe an IC under working conditions.

Technique looks promising for submicron ICs

"When you are trying to hammer out new high-speed products like microprocessors, you just never have enough hooks available to get in and test," says Anthony J. Gonzales, manager of the submicron lithography laboratory at Motorola Inc.'s Semiconductor Division in Phoenix, Ariz. "Voltage contrast gives you the opportunity to actually go inside a device and probe it," he says.

Gonzalez, who has been active in developing voltage-contrast test techniques, cautions that, although commercial systems are rapidly improving, "there are still some real physical problems that are not easily solved."

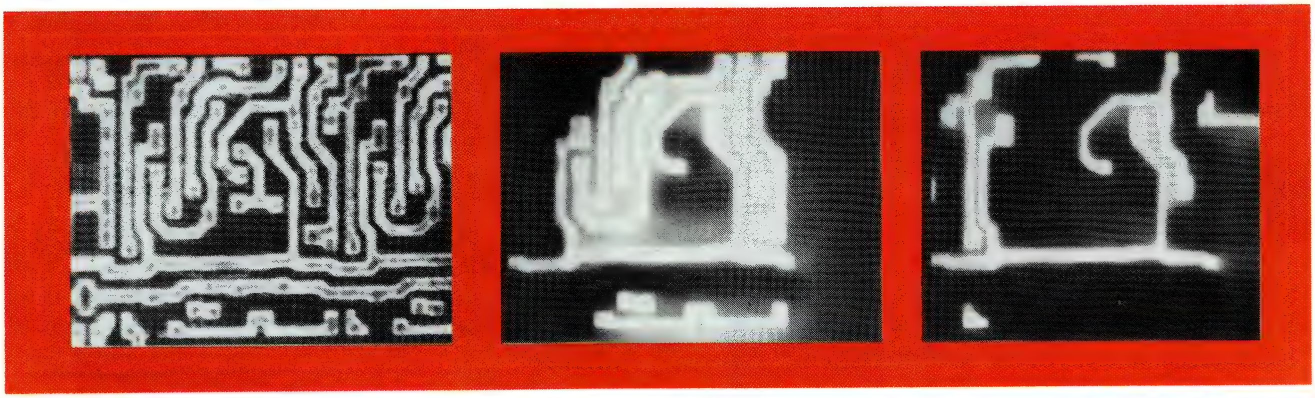
INTRODUCING ERRORS. For example, interference with electron trajectories is caused by transverse electromagnetic fields, which can alter the collection efficiency of the voltage-contrast system. In most voltage-contrast analyzers, the quantification of energy levels is not independent of the collection efficiency, so errors can be introduced.

Still, voltage-contrast testing already solves some problems. Manufacturing physical probes that can contact conductors less than 1 μm wide is not now feasible, scientists say. Even if it were, accurately placing the probes pushes the resolution limits of optical microscopes. There's a danger of breaking a conductor or bridging two conductors with the probe.

"Mechanical probes are becoming very difficult to use because of their relatively large size, and voltage contrast may soon be the only efficient way to test internal areas of highly complex prototype integrated circuits," says Frank Shepherd, manager of materials analysis for Bell-Northern Research.

Another drawback associated with mechanical probes is the introduction of stray capacitance on signal lines. As line geometries shrink, circuits become more susceptible to capacitive loading. Unfortunately, loading on the test probe remains constant, so the errors inherent in test values increase. Electron-beam probing simulates a probe with very high impedance and low capacitance, so loading is not a problem.

Jeffrey H. Bennett, manager of a CMOS systems design group at Bell-



SNAPSHOTS. A voltage-contrast analyzer uses an scanning electron beam synchronized with a logic circuit's clock pulse to show areas of high voltage. The image produced by different logic states (center and right) can then be superimposed on a physical picture of the IC area (left).

Northern, says problem-detection is faster. "With mechanical probes, testing is confined to a limited area of an IC. Voltage contrast scans a much wider area, making it possible to test in a few minutes what used to take weeks."

Bennett says he recently experimented with a chip with a known glitch. Conventional debugging techniques took a month to discover the problem area. When the same chip was placed on the voltage-contrast test bed, the problem area was located in several hours.

There are other companies that are making modified scanning electron-beam microscopes for voltage-contrast testing: Lintech Instruments Ltd., Cambridge, England, and Perkin-Elmer Corp.'s Electron Beam Division in Hayward, Calif. *–Robert Rosenberg*

BIOTECHNOLOGY

AUTOMATION IS COMING TO GENETIC RESEARCH

CHICAGO

A new industrial electronics market may be aborning in genetic engineering. The first wave of equipment designed to speed up the development of man-made genes is being introduced. "There is a tremendous need for automation, not only in research but in clinical use," says Robert Ledley, professor of physiology and biophysics at the Georgetown University Medical Center, Washington.

Ledley will be one of four biotechnologists to deliver papers on the subject at next week's Midcon '85 in Chicago. Ledley also headed a team that developed two dedicated genetic-research systems that will be marketed by An-Con Genetics Inc., a 2½-year-old Melville, N. Y., company. Both are designed to speed up time-consuming genetic-analysis procedures by automating the often tedious and complex manual tasks.

One system, known as the Automatic Genetic Analyzer, combines robotics and electronic detection with the use of biochemical probes to analyze genetic material (see "Automating the 'Southern blot' process"). The other system, called Metachrome, uses an automated microscope coupled with a high-speed camera and computerized image-processing system to measure chromosome spreads.

In the Automatic Genetic Analyzer, electronic detection substitutes for radioautography, an X-ray photographic method that is conventionally used for genetic analysis. Ledley notes that electronic detection is 10 to 100 times faster than radioautography and produces more precise results.

OFFICE TREATMENT. "Right now, the manual technique requires a highly skilled individual to do the analysis," says Douglas Gersten, a member of Ledley's Georgetown University team. But less skilled clinical-laboratory technicians can operate the Automatic Genetic Analyzer, he points out. The system could introduce a broader practice in the doctor's office that would include diagnosis, counseling, and possibly treatment of genetically transmitted diseases, notes Ledley.

An-Con funded the Automatic Genetic Analyzer development, which took two years and cost $550,000, in exchange for an exclusive manufacturing and worldwide marketing license for the system. The company intends to begin selling the system to the biogenetic research community during the first half of 1986, says An-Con cofounder and executive vice president Andrew Makrides. The system will cost about $100,000 and Makrides expects it will be available for clinical use during the second half of the year. Georgetown University will receive royalties on An-Con's sales of the genetic analyzer.

Electronic analysis is more precise than conventional methods

On the second front, An-Con received approval from the U. S. Food & Drug Administration in May to start clinical marketing of Metachrome, the chromosome-spread measurement device. Ledley's team had developed it earlier under the same type of funding, manufacturing, and marketing license agreement.

Previously, the measurement process required locating a chromosome spread through a microscope, photographing it,

AUTOMATING THE 'SOUTHERN BLOT' PROCESS

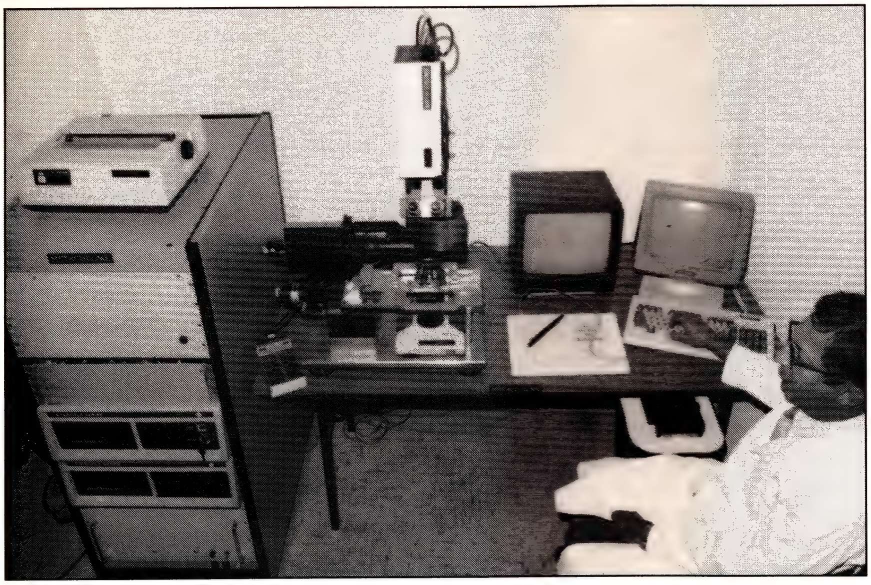
An-Con Genetics Inc.'s Automatic Genetic Analyzer automates the so-called Southern blot process, in which defective genes are identified by means of a biochemical probe that consists of a known DNA segment identified with a particular faulty-gene type. The system reduces the time needed to perform the process from several days to one, thus making the technique more feasible in a clinical setting. What's more, the system can perform up to eight different experiments simultaneously.

The probe is made radioactive with a beta particle emitter and is then combined, or hybridized, with a DNA sample taken from a patient. If the patient's DNA contains any sequence corresponding to that of the probe, the probe will cling to it. The presence of the target defective-gene type in the patient's DNA is thus confirmed by detecting the radiation after the hybridization process. An estimated 750 to 1,000 probes have been developed to date, enabling detection of genes for diseases including Huntington's chorea, thalassemia, sickle cell anemia, Lesch-Nyan syndrome, hemophilia, and muscular dystrophy.

The genetic analyzer system automates the Southern blot procedure by using a small robot that transfers the genetic sample among various test chambers. The DNA sample for a human patient is inserted into a gel, which the robot automatically subjects to a series of steps—electrophoresis, drying, hybridization, stringent washing, and finally detection.

Except for the hybridization stage, the system reduces the time required to perform each step, thanks to various electronic and chemical techniques coupled with the system's computer control, says Robert Ledley of the Georgetown University Medical Center, who helped design the system. The biggest time saving comes in the detection step. Current research practice relies on radioautography, in which the radiation is detected by exposing an X-ray film to the hybridized sample. But the Automatic Genetic Analyzer uses electronic beta counting with a custom 100-detector array developed by the Ledley team. "With radioautography, you put the gel in a freezer and wait for a few days to a week, because it takes that long to get an impression on the film," Ledley says. By contrast, the electronic detection system requires only 20 minutes to about 17 hours to read the sample.

A prototype version of the Automatic Genetic Analyzer is currently undergoing tests at Georgetown using human genetic materials. Such tests are required for Food & Drug Administration approval before the system can be marketed for clinical use.



ARRAY DISPLAY. The Metachrome system automates the measurement of chromosome spreads, displaying on a screen the array formerly put together from photos.

and karyotyping—manually cutting and pasting the photographs into an array the physician can study. Metachrome produces this array on a computerized display. The technique is useful for diagnosis of genetic defects in cells taken from an unborn fetus during prenatal testing.

"Metachrome does in a half hour or less what it takes several hours to do manually," says Makrides. The first five production systems are being built at Georgetown, with deliveries to begin by year end. Meanwhile, An-Con plans to set up a manufacturing plant or negotiate a manufacturing agreement with another company for Metachrome, with production to begin by early next year. An-Con's goals for Metachrome, which like the Automatic Genetic Analyzer will sell for about $100,000, call for sales of about 70 units during the first full year of production, rising to about 250 units by the fourth year.

Though projections are hard to come by on the potential size of the market for equipment that automates biogenetic techniques, Makrides says that in the U. S. alone there are about 1,000 research institutions and about 1,500 hospitals and genetic counseling centers that could benefit from either the Automatic Genetic Analyzer or Metachrome. Laird Jackson, director of medical genetics at the Jefferson Medical College in Philadelphia, says that the market is relatively small because the equipment addresses a complex mix of problems and is fairly expensive. But he adds that a major problem with systems currently on the market is a lack of service and support.

Makrides says An-Con will set up a field engineering network and sees no problems supporting the Metachrome system. The company has not yet completed its support plans for the Automatic Genetic Analyzer, however, and Makrides concedes this could be more difficult because of the system's relative complexity.

Jefferson Medical College's Jackson says the expected proliferation of biochemical probes over the next two to three years and expanded routine clinical use of prenatal diagnosis will fuel the need for automated genetic engineering. Such developments, he says, "will run the supply of technologists dry and will force the development of these systems." *-Wesley R. Iversen*

INTERNATIONAL TRADE

JAPAN CALLS SIA CHARGE 'RED HERRING'

WASHINGTON

The Electronic Industry Association of Japan has dismissed as a "red herring" the Semiconductor Industry Association's complaint that U. S. chip makers are being denied fair access to Japanese markets. The EIA-J has also charged that the SIA petition filed under Section 301 of the Trade Act of 1974 "has no basis in law or reality." In fact, Japan's semiconductor market "has been completely liberalized for trade and investment for over a decade," asserted the blunt EIA-J rebuttal, filed last Monday.

But, contends the U. S. trade association, the EIA-J is playing a "numbers game" that obscures but cannot change the fact that U. S. penetration of Japan's integrated-circuit market has been stagnant and declining while Japan's share of the U. S. market has been steadily growing.

To prove its point, the EIA-J cited semiconductor trade figures that are at odds with those reported by the SIA [*Electronics,* Aug. 19, 1985, p. 15]. The EIA-J cited data from the Ministry of International Trade—"since they are the product of greatest importance to the U. S." According to MITI's figures, the U. S. currently has a 2 : 1 success ratio over Japan, holding a 19.1% share of the Japanese semiconductor market while Japan commands only 9.6% of the chip market in the U. S.

Japanese chip market has been liberalized for over a decade

The SIA's calculations, based on data from the World Semiconductor Trade Statistics program covering 98% of U. S., European, and Japanese shipments and the U. S.-Japan High Technology Working Group, give Japan 17% of the the U. S. market and American producers 11.9% of Japan's.

The SIA's figures are misleading, argued EIA-J representatives, because they include all types of semiconductors rather than ICs alone and exclude U. S. shipments from offshore manufacturing facilities. Furthermore, the EIA-J maintained that the SIA has grossly inflated Japan's position in the U. S. by excluding U. S. captive production by such firms as IBM Corp. and AT&T Co. At the same time, the SIA deliberately included Japanese captive sales in order to downplay the U. S. presence in Japan, alleged the EIA-J.

CONSUMER BIAS. William Tanaka, Washington counsel to the EIA-J, called the whole market-share issue irrelevant. The main reason U. S. companies cannot gain market share in Japan, he said, is that demand is mainly (47%) for consumer ICs, an area in which U. S. companies are not strong.

"In attempting to refute the SIA's case, it appears that the Japanese have employed data from a variety of nontraditional sources, and that data may be inaccurate and/or misleading," the SIA said. Moreover, "they know perfectly well that by international agreement, World Semiconductor Trade Statistics data does not include nonmerchantable manufacturing. There is no way their numbers are correct," added an SIA spokesman.

The SIA also lashed out at the EIA-J for referring to the 301 action as a "narrow-interest" move on the part of "certain nonintegrated merchant producers only." SIA membership includes captive producers and none of them voted against the petition, although "they would be hurt first and most by a protectionist solution to the problem," reports the spokesman.

EIA-J figures are at odds with the SIA's

In playing a numbers game, the Japanese are trying to invalidate the merits of the SIA case, remarks SIA attorney Michael Gadbaw. But no accounting measures, he says, can alter the fact that U. S. chips have not been welcome in Japan except when short supply or proprietary design necessitates their acceptance. As a result, U. S. companies have had no choice but to divest from Japan, which is what the Japanese want to happen, Gadbaw contends.

Meanwhile, trade negotiators from Washington and Tokyo have agreed on procedural measures to resolve the 301 action by late December. The SIA is lobbying for an effective and lasting settlement, which Gadbaw believes must entail restructuring Japanese intercorporate relationships. Only if Japanese companies drop their loyalties toward one another and treat foreign companies as equal partners will U. S. chip makers get a shot at Japanese markets, he says.

The Japanese, however, are convinced the problem stems from the boom-and-bust nature of the U. S. market, which often catches suppliers short when demand surges, says Tanaka. For that reason, the Japanese are reluctant to form long-term partnerships with U. S. IC houses and are taking the position that the issue should be addressed through managerial rather than legal action, he says. *–Karen Berney*

ENGINEERING SOCIETIES

BACHMAN, CRUZ VIE FOR IEEE TOP SPOT

NEW YORK

The race is on for the office of president-elect of the Institute of Electrical and Electronics Engineers. A repeat candidate, Jose Cruz, and IEEE treasurer Henry Bachman are the candidates. Emerging as issues are media coverage, restrictions on technology transfer, and continuing education of IEEE members.

Ballots were sent to members over the Labor Day weekend and are due back on Nov. 7. The winner will serve one year as president-elect and then one year as president.

Cruz is concerned with media coverage of the organization and with its relationship to government. And he has proposed that the press be invited to meetings of the IEEE's board of directors. The 52-year-old University of Illinois professor of electrical and computer engineering believes that policy would minimize the misunderstandings and misinterpretations that turn up in print.

Cruz, who lost last year's race by 279 votes out of 45,000 cast, is realistic about his proposal: "I know there will be some opposition, but I hope we would be able to reach a compromise." Closed executive sessions could be held when personalities and other sensitive issues are discussed, he says.

Bachman is focusing on a more global communications issue: the dangers of federal restrictions on technology transfers. "I wouldn't want to support any protectionist measures," says the 55-year-old vice president for engineering at Hazeltine Corp. in Commack, N. Y. "The restrictions are going to cause more harm than good. They will have a chilling effect not only in technical information but also in how that information is embodied in products."

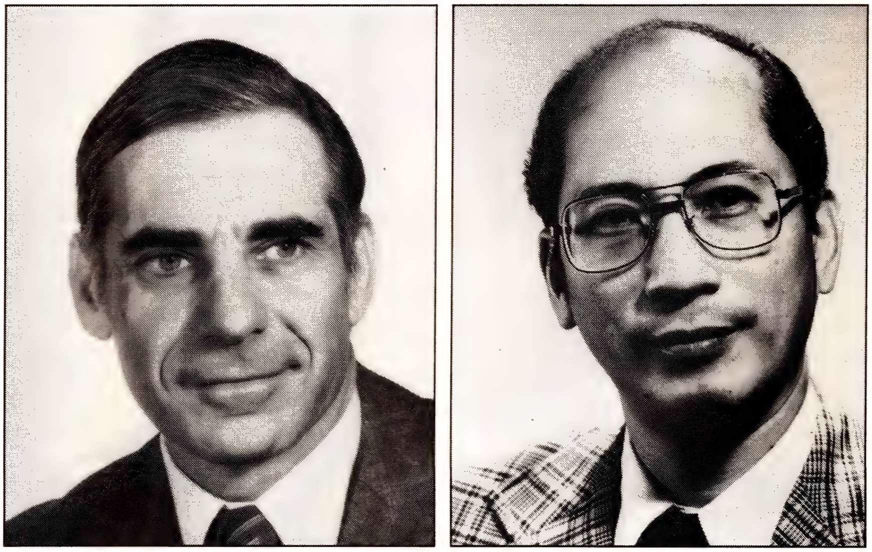
He says that, under federal restrictions, some IEEE conferences would never take place because the subjects would be deemed too sensitive for international consumption. That could rend the IEEE's international fabric by effectively closing the organization to its foreign members.

EDUCATIONAL ROLE. Another key issue in the campaign is the respective roles of the IEEE and industry in fostering lifelong learning for engineers. Both candidates advocate an increased role for industry, but Cruz puts more emphasis on the individual's responsibility to seek out retraining.

Bachman says the IEEE has been unsuccessful in its retraining efforts and maintains that the organization "can and must do more." He believes businesses, universities, and technical societies play vital parts in fighting professional stagnation.

"An individual has to have lifelong learning among his top priorities," Cruz urges. "The most important factor is a stimulating work environment." The best way for a company to foster the desire to keep learning is to provide the opportunity for an engineer to grow in his or her job, he says, warning that stagnation in the workplace leads to stagnation in the mind.

Bachman "would like to see every IEEE member be a member of a technical society" within the IEEE or of a local IEEE chapter. He acknowledges that only about 60% of the members currently fit that bill. Members not affiliated with a technical society, he says, miss out on valuable information the IEEE provides. "One approach to prevent this loss," Bachman proposes, "is to have more customized delivery of our technical products, by using the technical interest profile we have on file for each member to aim reports and papers at the right portions of our membership." *–Tobias Naegele*



IEEE CANDIDATES. Henry Bachman, left, IEEE treasurer, is running against repeat candidate Jose Cruz from the University of Illinois for the office of president-elect.

SINGLE-CHIP DECODER PROCESSES TV STEREO

AGRATE, ITALY

The debut of TV transmission with two sound channels in West Germany four years ago gave integrated-circuit makers an opportunity to hone their stereo sound-processing techniques for what promises to be a growth market. Italy's principal semiconductor component manufacturer accepted that challenge and has come up with a solution that it believes may well be optimal in terms of price and performance.

In addition to being the first one-chip decoder and audio processor for dual-channel TV sound, the CMOS circuit is easily adaptable for stereo transmission elsewhere, say its designers at SGS Microelettronica SpA. SGS expects to have first silicon of the M8793 this year.

The SGS approach combines both analog and digital circuits: it employs switched-capacitor filters and digital control by a microprocessor over a serial data bus. But the design reopens the question that has been the subject of fierce debate between producers of signal-processing chips for television pictures: whether the better solution is to convert the signal and process it in digital form or to treat it in its original analog form.

"There's no question about it, complete digital treatment is very attractive because of full software programmability and digital controllability of the resulting system," admits Giancarlo Caironi, SGS's product marketing manager for MOS ICs. "But in current TV broadcasting systems, transmitted audio signals are analog. So solutions based on digital signal-processing techniques are rather expensive because they require analog-to-digital and digital-to-analog converters in addition to the logic necessary for the processing itself."

A fully digital approach has been developed by Intermetall GmbH in Freiburg, West Germany [*Electronics*, July 15, 1985, p. 27]. The ITT approach requires two digital processing chips in addition to an ADC and a DAC.

The German stereo system transmits two carriers with the video signal, but they are separated from it by 5.5 and 5.742 MHz. Audio signals frequency-modulate both carriers to form two distinct sound channels. These two channels are used in three different modes: monophonic, stereophonic, and bilingual.

Chip reopens debate: whether to process signals digitally

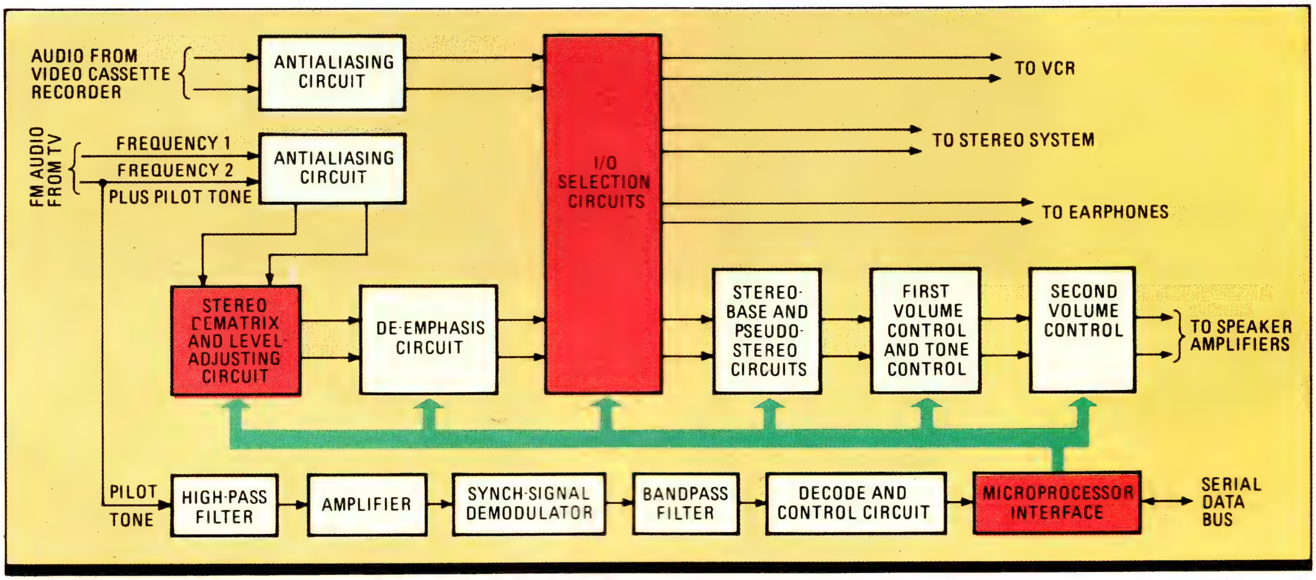
The SGS single chip destined to process this signal, said by SGS to be one of the most complex circuits yet developed using switched-capacitor techniques, is produced in silicon-gate CMOS technology. The IC is divided into two modules: a pilot-tone decoder and an audio-signal processor. The first uses a sequence of high-pass filter, amplifier, demodulator, bandpass filter, and decoding and control circuitry to determine from the pilot tone which of the three modes it is receiving. This information is then loaded into a register contained in the chip's microprocessor interface. Over the serial data bus, the microprocessor reads the data and then selects the correct operating mode of the audio-signal-processing section.

When the signal is identified as stereo, it goes through a low-pass antialiasing filter; then the signal is dematrixed, using the matrix coding of the German system, to obtain the left stereo channel. To achieve this, the input signals of the two carriers are adjusted by the factory to minimize crosstalk between the right and left channels.

DIGITALLY ADJUSTED LEVELS. The TV-set factory uses programmable capacitive dividers to digitally adjust the input level of the two carriers on each TV set. Values of the resulting coefficients are stored in a nonvolatile memory, from which they are recalled each time the set is switched on.

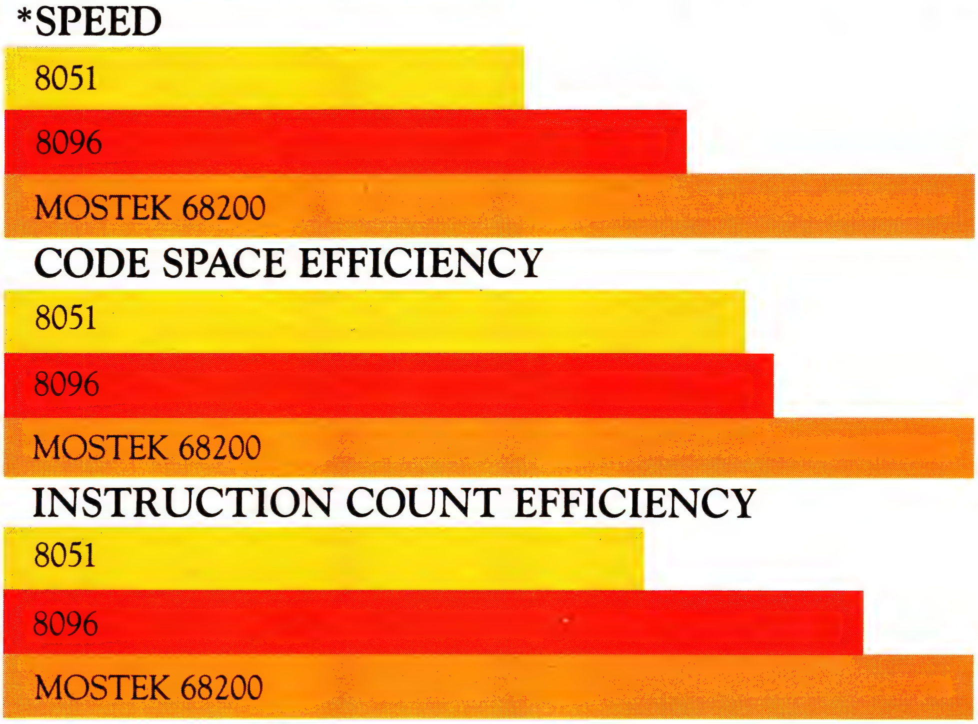
After deemphasis of the dematrixed signal by a simple, one-pole switched-capacitor network with a time constant of 50 µs, the circuit selects the appropriate output: video cassette recorder, hi-fi system, earphones, or loudspeakers. The circuit then modifies the signal to give the listener the impression that his speakers are farther apart than 70 cm, the distance that separates them on a standard TV set. This is done by inducing out-of-phase crosstalk between the two channels in midrange frequencies. Finally, the signal is volume-controlled to set it up for the tone controller, tone-controlled, and volume-controlled a second time to adjust output level.

Where the signal is monophonic, the stereo base-width enlargement is replaced by a process that splits the monophonic audio signal into two frequency bands feeding the left and the right channels with different frequency components. This scheme gives a pseudo-stereo effect. *–Robert T. Gallagher*



UNDER CONTROL. SGS uses a switched-capacitor analog CMOS chip with external digital control to decode and process stereo TV sound.

ANYTHING ELS



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THIS ELECTRONICS WEEK

MOSTEK DROPS 500 IN LATEST LAYOFF

Though United Technologies Corp. solved one of the more pressing problems at its Mostek Corp. subsidiary by naming James R. Fiebiger to the presidency of the company, a job that has been vacant for months (see story, p. 16), it is still letting go hundreds of employees at the troubled chip maker. In the most recent of a series of layoffs, Mostek announced late last month that it was trimming 500 from its work force in Carrollton, Texas, because of continued weakness in the markets for dynamic random-access memories. Mostek already has let go 4,560 workers worldwide since the beginning of the year, bringing its total work force now to just over 5,000.

JULY DATA SHOWS TEST GEAR GAINS

Despite the current slump in sales of semiconductors and other electronic components, a new monthly report from the National Electronic Distributors Association, which has headquarters in Chicago, shows that electronics distributors are doing well in at least one category—test and measurement equipment. The category showed a positive 1.01 : 1 book-to-bill ratio for equipment sold through distributors in July, the first month for which data was collected, according to the association. That contrasts with a 0.97 : 1 ratio in July for the association's Distribution Business Index, which tracks all types of products sold through distribution.

JAPAN DROPS COMPUTER TARIFFS

In what the Computer and Business Equipment Manufacturers Association describes as "a gesture of good will," Japan has agreed to remove its import duties on mainframe computers, peripherals, and parts, which are 4.9%, 6%, and 4.9%, respectively. In return, the U. S. will drop its 4.3% tariff on computer parts. The 3% U. S. duty on mainframes and 4% duty on peripherals will remain. The association says that the agreement will help increase U. S. sales of equipment to Japan and make "at least a small dent in the trade deficit."

VOICE TEST GEAR MARKET TO TRIPLE

One market created by AT&T Co.'s breakup is that for voice remote test equipment. A new study by Frost & Sullivan shows sales will triple to $670 million annually by 1993. The New York market research says the divestiture freed Bell operating companies to purchase equipment on the open market. This created new testing needs in regional calling areas, where bypasses require test equipment, and shifted more responsibility for maintenance to the end user.

TANDON AND TEAC SETTLE THEIR FIGHT

Tandon Corp. of Chatsworth, Calif., and Teac Corp. of Tokyo have settled Tandon's claims before the International Trade Commission that Teac's double-sided floppy-disk drives infringe on Tandon's patent. Tandon will license Teac to manufacture 5¼-in. drives in return for what it calls a significant initial payment plus royalties on sales of Teac's 5¼-in. doubled-sided floppy-disk drives.

ISRAELI COMPANIES SEEK RECRUITS

Israeli high-technology companies are mounting a drive in North America to recruit hundreds of engineers and technological marketing specialists. Twenty companies will participate in a series of "opportunity expositions" from Oct. 30 through Nov. 14 in four cities: Los Angeles, New York, Toronto, and San Jose, Calif. The Israelis hope their recruiting drive will help reverse a technological drain to North America and attract new immigrants and graduates.

NONINVASIVE TEST MADE OF HEART

General Electric Co. reports that one of its scientists has performed a noninvasive chemical analysis of a living human heart. Paul A. Bottomley, a physicist at the GE Research & Development Center in Schenectady, N. Y., used depth-resolved magnetic-resonance spectroscopy, a technique that combines magnetic fields 30,000 times as strong as the earth's, radio waves, and computers to sample the chemistry of living body tissues. The relative quantities of certain key chemicals are then displayed as peaks on a computer printout. The technique is related to magnetic-resonance imaging, which uses magnetic fields and radio waves to take pictures of organs and body structures.

VHSIC CHIP SET PASSES FIRST TESTS

Westinghouse Electric Corp., Baltimore, and National Semiconductor Corp., Santa Clara, Calif., have successfully demonstrated the performance of their chip set for Phase I of the Defense Department's Very High-Speed Integrated Circuit program. The set consists of a 64-K static random-access memory, a 16-K SRAM, and a 10-K gate array with 8,000 user-programmable gates and 152 programmable input/output pins. Each chip has one polysilicon and two high-density metal layers. The 8-K-by-8 SRAM, operating at 30 MHz, has shown a throughput rate of 8×10^{12} gate-hertz/cm^2, which is 16 times more than the military requires of chips that are submitted in Phase I competition, according to Westinghouse.

Meanwhile, a workshop for design teams will be held Sept. 10-12 at RCA Corp.'s David Sarnoff Research Center in Princeton, N. J.

SOFTWARE ZOOMS IN AFTERMARKET

Although the personal software market continues to look bleak in the wake of sluggish microcomputer sales and the demise of many small software houses, the aftermarket is taking on a healthy glow [*Electronics*, Aug. 26, 1985, p. 21]. A study by market-research company International Resource Development Inc., Norwalk, Conn., says aftermarket sales—already surpassing initial software-package sales revenue—will account for an estimated 84% of total industry sales by 1995, compared with about 60% this year.

COMPANYWIDE LICENSING FAVORED

A sampling of Fortune 1,000 companies reveals that 66% of the respondents favor companywide licensing of software products rather than just single-site licensing, according to Forrester Research Inc., a Cambridge, Mass., office-automation market-research company. Another 27% prefer site licensing; only 7% favored licensing on a per-computer basis.

IC SALES EXPECTED TO BOUNCE BACK

Free-world production of semiconductors should surpass $34 billion in 1986, but that will be below the 1984 output, estimates Henderson Ventures, a Los Altos, Calif., market research company. It expects production in 1986 to be up 11.4% over 1985. But this won't be enough to overcome the 11.8% drop in production this year from 1984, says the company.

INDIA STRIVES TO JOIN HIGH-TECH WORLD

PRIME MINISTER GANDHI'S PUSH BEGINS TO ATTRACT U. S. COMPANIES

by Vyvyan Tenorio

NEW DELHI

In a small electronics factory in the dusty outskirts of New Delhi, young women in colorful saris are sitting on rickety wooden chairs at small tables that look almost like school desks. They are testing high-grade silver-mica capacitors used in electronic instruments to make sure they meet quality standards of the company's export markets in the U. S.

The factory provides contrasting images that, in many ways, mirror the country's current efforts to go high tech. Despite India's underdevelopment, the government wants to yank the country into the computer age by liberalizing its tightly controlled computer and electronics industries. U. S. and European companies are taking the bait.

U. S. companies such as Apple, Burroughs, Data General, Tandy, and Wang, as well as such European counterparts as Acorn and Sinclair, have lost no time in taking advantage of the changes and are tying up with local companies. Apart from India's having low wage scales and one of the world's largest pools of skilled technicians, these companies hope to tap what they believe could be one of the largest markets in the world.

"Although the market isn't here yet, [U. S. and European computer companies] think that with India's 750 million population, it's important to maintain at least a presence here," says a Westerner whose large U. S.-based computer firm has been negotiating for a software facility in Bombay.

Much of the impetus for India's new policies comes from its prime minister, Rajiv Gandhi, who took over the helm of government late last year. His goal for India is to produce about $8 billion worth of electronic equipment, including computers and consumer goods, by 1990, the end of the nation's Seventh Five-Year Plan. The target for computers is 100,000 units annually by 1990, compared with the current rate of 5,000.

To get his program rolling, Gandhi has taken personal charge of India's Department of Electronics, which has become a separate ministry. He has more than the usual interest in computers. The 40-year-old former airline pilot not only spends several hours a week in computer training, but he could be the only head of state in the world with a knowledge of computer programming.

CHECKING IT OUT. An Indian worker tests components at Hindustan Cables Ltd.

FAST-TRACK ADMINISTRATION. The head of state's closest advisers are popularly referred to as "Gandhi's computer boys" for their expertise in the field. Most of their offices, in fact, have computer links with the office of the prime minister. Gandhi has opted for a fast-track style of administration, evidently intent on liberalizing the heavily controlled Indian economy to stimulate faster industrial growth.

India still has a long way to go. Its technology lags behind that of other Asian countries, and domestically made computers are generally clunky imitations of foreign brands. Most India-made computers depend on imported components: they are then assembled in India with locally manufactured cabinets. Consumer electronics goods, such as TV sets and transistor radios, are likewise poor imitations of foreign brands, despite the efforts to copy foreign designs, names, and technology. Much of the manufacturing process still depends on manual batch production.

Western diplomats and businessmen fully back Gandhi's pragmatic approach, a sharp contrast to the stodgy socialist framework that dictated India's policies for decades. Those policies did little to build a domestic electronics industry. Last year, electronics production totaled $1.6 billion, barely 1% of Japan's annual production. Of this, sales of computers totaled only $110 million (at 12 rupees to $1), with about $34 million going to minicomputers, and $12 million to large systems, according to one survey.

But the government's "whole approach has gone through a big change since November," says Narasimhiah Seshagiri, assistant secretary of the Department of Electronics. A new computer policy was outlined at that time, followed by more specific guidelines on electronics announced in March and April of this year.

Briefly, the policies provide for:

- Liberalization of cumbersome industrial licensing procedures.
- Relaxation of import restrictions and reduction of import duties on certain types of electronic components and computer-related items.
- Measures allowing 40% foreign equity in electronics manufacture, and more than 40% foreign equity participation in certain high-technology areas "where the country has not been able to invest sufficiently in research and development."

WELCOME MEASURES. These measures were welcomed by the private sector, which has blamed the Department of Electronics for retarding the growth of the electronics industry through its crippling restrictions. "The department was one of the most hated government institutions in the country," says an Indian entrepreneur. He accuses the department of "a narrow perspective in claiming that it knows everything and that it can do everything."

Other industrialists agree, saying that Gandhi's measures are merely piecemeal efforts that reflect the government's present confusion over how best to go about developing the electronics industry. Too much emphasis has been placed on mass production, they say, and not enough on developing the market.

"The industry just isn't mature enough to have economies of scale," says Ashok Ahuja, a private businessman and consultant to investors from the U. S. "People are going slow in capital investments until the market has grown."

Some locally made computers can cost more than twice as much as their foreign equivalents. Import duties designed to protect local industries are still high—75% on electronic components and 200% on computers and computer systems that cost up to about $8,000. In addition, only large computers costing the equivalent of $8,000 will be allowed entry into the country.

This means, of course, that imports of personal computers are effectively banned unless some mitigating reason is put forth to the government. In that case, an individual import permit is granted for a single unit, a procedure guaranteed to dampen the enthusiasm of any manufacturer of smaller computers.

India's fear of multinationals barred foreign computer firms

India's longstanding fear of domination by multinationals in business and industry has barred the entry of foreign companies to the computer-manufacturing sector in the past. Under the more liberal government attitude, companies that have 40% foreign equity may now go into any electronics manufacturing field, provided they commit from 50% to 70% of production for export.

In the past six months, a number of companies have begun negotiations with Indian parties for technical collaboration agreements. These talks generally center on phased manufacturing programs in which technology is transferred to the local company in return for lump-sum fees plus royalty payments for a specified number of years. Under the phased programs, computers or computer-related products initially will be assembled or manufactured in small quantities, depending on market growth.

NCR Corp., Dayton, Ohio, has teamed with Crid Ltd. in Bhubaneswar, Orissa State, to manufacture proof encoders, passbook printers, and systems based on microprocessors or minicomputers, according to Ministry of Industry sources. NCR could not confirm or deny the report. Burroughs Corp., Detroit, already has a 40% interest in an Indian joint venture, Tata-Burroughs Ltd. of Bombay, and plans to come up with a bigger proposal for technical collaboration to manufacture computer systems.

Smaller American computer companies are collaborating with U. S.-based Indian businessmen interested in investing in India. For example, Commodore International Ltd. has entered into an agreement with Orissa State Electronics Development Corp. for the manufacture of Commodore personal computers in India.

Tradecom International BV of the Netherlands recently signed a technical-collaboration deal with Megabyte Consultancy Services Ltd. in Bombay to manufacture microcomputers for 50% domestic distribution and 50% export. About half of the initial 10,000 units of the resulting New Brain products will be exported to Europe, Africa, the Middle East, and Southeast Asia. Acorn Computers Ltd., of the UK, and Semiconductor Complex Ltd., Chandigarh, capital of Punjab-haryana States in northern India, have begun to manufacture printed-circuit boards for the British Broadcasting Co. as part of a small-scale technical-transfer agreement. Philips of the Netherlands is collaborating with Bombay's Pieco Electronics Ltd. in the manufacture of hard ferrites and automated scientific instruments. Philips is reportedly considering expanding the collaboration to include the manufacture of peripheral equipment.

HARDEV SINGH

PROGRESS LOOMS. Its name to the contrary, Delhi Cloth Mills is a leading maker of computers.

Tandy Corp. has been collaborating with India's Delhi Cloth Mills Ltd., a prominent mainframe computer manufacturer despite the anachronistic name. According to Dave Christopher, senior vice president of Tandy's Trading International Division, the Fort

Worth, Texas, company originally sought a partner in India because it was virtually impossible to get a license to bring computer products into the country. The Indian company now manufactures the DCM-Tandy computer (Tandy's Model 4) from parts which are both locally manufactured and imported.

The two companies have forged close relationships. In addition to manufacturing the Tandy machine, Delhi Cloth Mills writes software for the American company. "They have very competent people there," says Christopher. The company has even set up an office in Forth Worth to be close to Tandy. The Indian government recently approved Delhi Cloth Mills's application for an estimated $10 million expansion.

BIG BOYS PLAY, TOO. Several other big players on the international scene are contemplating similar tie-ups with Indian partners. Hewlett-Packard Co., which distributes locally through Blue Star Ltd., New Delhi, sent several executives to India last spring in order to assess the market potential for its products there. Though no decision as to corporate strategy has yet been made, the Palo Alto company is currently "looking at the situation," says a company spokeswoman. Meanwhile, Indian government sources report that HP has filed an application with the Indian government for a technical-collaboration scheme with Blue Star.

IBM Corp., which left India in 1978 after disagreements over technology transfers and equity holdings, has not marketed actively in India since. But it is believed to be reassessing conditions. There is talk, says a government source, about setting up an IBM software unit under the new 100%-equity scheme in high-tech areas. IBM would not comment.

Despite its tentative moves toward liberalization, government regulations are still capricious and companies remain wary. For example, in expectation that it could sell its computers under an open general license with only a few tariff restrictions, Apple Computer Inc. signed an agreement last April with New Delhi distributor Rava Contel Ltd.

Subsequent to this, the government changed its restrictions regulating computers, forcing the Cupertino, Calif., company to apply for a separate import permit on each sale it wanted to make. Recognizing that "the only way for us to get into the Indian market is through joint venture," says a company spokeswoman, Apple is currently studying its options.

Sinclair Computers Ltd. of the UK, after an unsuccessful attempt to sign up with Macmillans Pvt. Ltd. of Calcutta, is looking for a new partner to produce small home computers. And Siemens AG of West Germany is looking for an Indian partner to manufacture a range of semiconductors for the domestic market.

The government also envisions setting up "electronic cities" or "technology parks" patterned after the Silicon Valley model. These will provide facilities for large-scale computer software investments for 100% export.

Investors think India could be one of the world's largest markets

Texas Instruments Inc., Dallas, got approval early this year for a sophisticated software-development center in Bangalore, in Karnataka State, which the Department of Electronics says will cost an estimated $100 million. It has begun recruiting over 100 engineers and programmers. The 100%-foreign-owned facility also was recently given the go-ahead for a private or dedicated satellite data link critical to the center.

BLESSINGS. A visiting U. S. representative observes a production line turning out mica capacitors at JV Electronics Ltd.

Similar proposals or export zones are being discussed for Haryana and Orissa and the states of Hra Pradesh and Maharashtra. These include a plan by Westinghouse Electric Corp., Pittsburgh, to collaborate with nonresident Indian concerns in development of an $80 million center in Kotagiri, Tamil Nadu State.

In telecommunications, the government has loosened controls over the manufacture of certain items such as telephones, equipment for private branch exchanges, and telex machines, reversing the practice of state monopoly. To replace antediluvian telephone systems in the country, India has approved various foreign technologies—from Siemens, Ericsson, and ITT, among others—for technology transfers in digital switching to selected Indian companies. In the meantime, it has bought CIT-Alcatel's E10 systems for large exchanges and a second contract for a second phase is likely to be approved in the next few weeks.

At the same time, the government late last year set up the Center for Development of Telematics specifically to develop indigenous digital communications systems based on locally available components. Spearheading the center's work is an Indian-born electronics expert, Satyen Pitroda, who holds more than a dozen patents in electronic switching systems from his years in the U. S. with GTE Corp.

OFFICIAL CONFIDENCE. Although Indian private industry is skeptical, Petroda is confident that within three years and with a minuscule budget of $29 million, the center will achieve its targets. The prime minister himself has expressed support. "I am hoping that the indigenous telecom system will be as good if not better than anywhere else in the world," he told a group of journalists in New Delhi in July.

For large and sophisticated computer systems, India hopes that a recently signed memorandum of understanding on high technology will lead to quicker transfers of technology from the U. S. In the past, such transfers have been held up by the U. S. government's fears that technology might end up in the hands of the Soviet Union or that it might be applied to nuclear purposes. Some of the proposed technology transfers include electronic components and equipment for applications in telecommunications, science, industry, and defense.

However, it appears that the memorandum, which was signed last May, has run into some snags recently because the U. S. would like to have India's assurances on safeguards clearly spelled out. Indian government sources say the snags might be eliminated "very soon." Should this happen, the memo would pave the way, for instance, for the approval of a computer purchase by the state-run Oil and Natural Gas Commission. It has been negotiating with IBM for almost two years.

Visions of a computerized society run into glitches

The government is talking about acquiring supercomputers such as the Cray XMP, but potential users are extremely limited. The largest computer system in the country today, Cyber CDC 170-730, belongs to the government's National Informatics Centre, a computer-based government information network managed by the Department of Electronics.

The agency plans to install NEC Corp.'s System 1000 computers, the high end of the Acos mainframe series, for new offices later this year. Additional purchases are under scrutiny, depending on availability of funds.

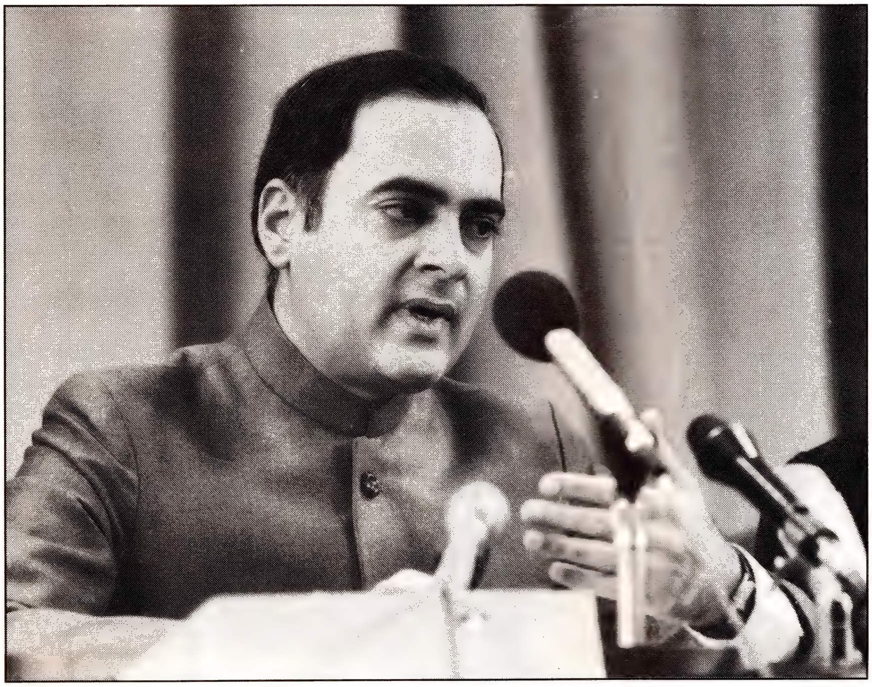
India is currently undergoing a financial-resources crunch which could severely hamper its five-year plan's programs. An initial Department of Electronics request for a $1 billion budget for the five-year period appears likely to be slashed to around $400 million. The department hopes that the private sector would take up the shortfall, and then some.

India's vision of computerizing its society constantly runs into glitches. For one thing, it lacks the money to support its programs in the public sector, the source of the biggest potential clients. For example, the national railway computerization program has been in the planning stage for nearly four years. The railroad just recently signed a $400 million contract with Canac of Canada for a program that would computerize India's railway system. State banks are running into trouble implementing their own computerization plans because of labor unions' strong opposition.

More fundamental are the continuing deterrents to capital investments in India. Poor infrastructure and environmental conditions, endless red tape, and limitations on foreign investments remain. "The problem is, many of the progressive policies have not trickled down to the bureaucratic levels," complains an American businessman.

The prime minister's office recognizes these impediments. As one high official in the Gandhi government remarks, "Obviously, the problems are still around. But we would like to have very large investments in the high-technology areas. The need is there. We have to find ways to meet those needs." ☐

TECHNOLOGY BOOSTER. India's youthful prime minister, Rajiv Gandhi, has taken personal charge of redirecting the country's electronics industry.



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Electronics September 30 issue

Telecommunications Chips

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The Market
The digital signal processing chip market is predicted to hit $375 million this year and grow to $1 billion by 1990.

Target Readers
IC manufacturers, PBX and telecommunications switching equipment manufacturers, digital design engineers, analog design engineers, engineering managers, telecommunications analysts.

Issue Date:
September 30, 1985
Closing for Advertising:
September 9, 1985

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Electronics October 7 issue

Technology Update: Computers

Special Advertising Section: Germany

Learn why parallel multi-computer and multi-processing architectures, reduced-instruction-set computers, and artificial intelligence are having a special impact on computer technology. Optical storage in the area of peripherals will also be covered.

The Market
$70.4 billion in the U.S. in 1985;
$80.7 billion in 1986.

Target Readers
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Issue Date:
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Closing for Advertising:
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OPTICAL FIBER MAKES MOVE IN DATA COMMUNICATIONS

VENDORS PUSH THE TECHNOLOGY AS A MAJOR MARKET CONTENDER

by J. Robert Lineback

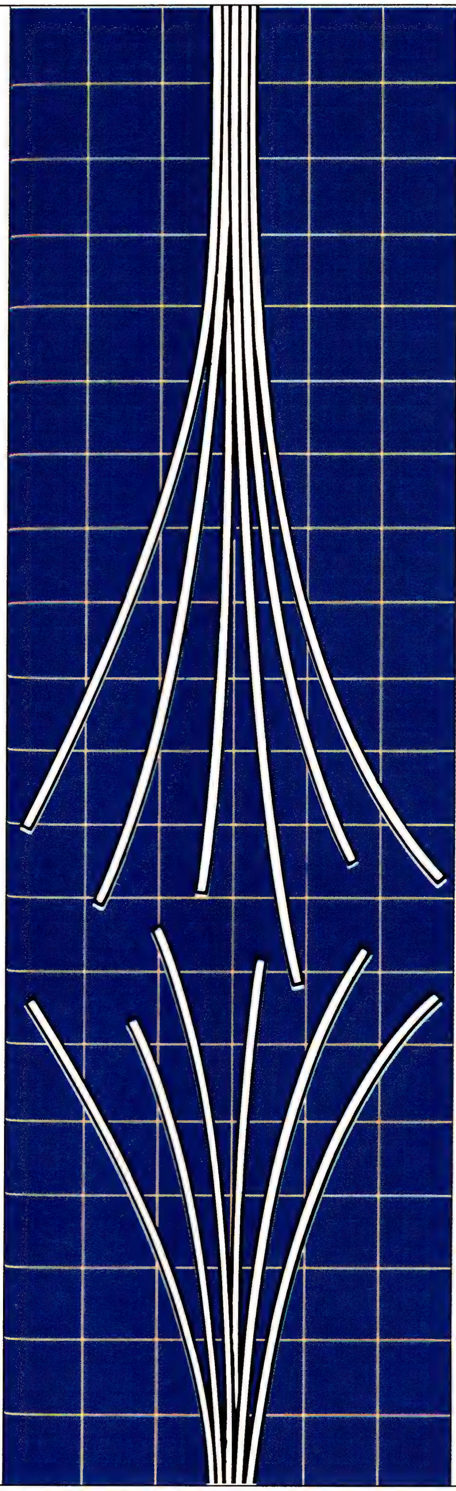
DALLAS

Ever since the marriage of low-loss optical glass fibers and light-emitting diodes, lightwave communication has shown great potential as a medium for both voice and data transmission. But so far, its only big success has been over the long-haul/long-distance telephone lines: optical fiber has not been used much to link computers, even though it delivers a powerful combination of high speeds, long distances, and immunity to electrical noise. The biggest obstacle is industry's considerable investment in existing copper links.

But a growing number of vendors of fiber-optic systems, including communications giant AT&T Co. (see "AT&T says 1986 is the year," p. 31), plan to carve inroads in the data-communications market. Despite some skepticism on the part of industry analysts, these companies are introducing products and perfecting plans to unleash fiber optics from its current small but well-positioned corners in data communications. Manufacturers are pushing the technology as a major contender for computer links throughout the office, factory, and eventually, even the family car.

Proponents say that optical-fiber data links are gaining larger market shares in many digital-processing jobs, such as military equipment, untappable high-security links, spacecraft, high-resolution color graphics, and electrically hostile environments. From these bases—plus the spread of fiber optics in digital telephony—the lightwave technology will have its brightest chances of invading the general marketplace, suggests Jon Glasco, analyst and manager of the fiber-optics group at Electronicast Corp., a market research company in Redwood City, Calif.

Some market analysts, however, point out that optical data links and lightwave local-area networks face a tough fight if they are to supplant established metal-based computer cables and coaxial-based local-area networks. These analysts wonder whether the new kid on the block can handle the battle.



"No doubt in the last year or two there has been a lot more consideration given to fiber-based systems for data links and LANs, but we still don't see a lot of penetration in computer communication markets," states Glasco.

According to Electronicast, fiber-optics sales in U. S. data-communication markets will reach only $50 million in 1985. That is just 4% of the estimated $1.25 billion market served by metallic cables and optical fiber combined, says Glasco. Optical fiber's share could move up to 8% in 1990, with annual sales totaling $500 million compared to a total market of $6 billion (see chart).

"Since 1979, fiber optics has been making the move toward being more suitable for shorter distances at lower data rates," explains Bart Bielawski, a pioneer in the field who is now senior vice president of corporate development at Siecor Corp., Research Triangle Park, N. C. The fiber-optics component company is a joint venture established by Siemens AG and Corning Glass Works. "I think what we are seeing today is that it is crossing a 'magic line,' which makes it cost effective for even a few hundred feet at data rates as low as a few megabits per second.

"The period between now and 1986 for data communications is going to correspond with 1979-81 for telephony, where the level of activity grew from a few million dollars a year to tens of millions a year to eventually hundreds of millions," he projects. Bielawski believes that fiber-optic and twisted-pair links are likely to squeeze out coaxial cable from their high and low ends of local computer networks. "Coax is stuck right in the middle."

SMART BUILDINGS. Optical-fiber cable is approaching computer installations on several fronts. The "intelligent" buildings that have cable already installed so that tenants merely have to plug in their LANs are laying the groundwork for an eventual lightwave-data age, say optical-fiber proponents. Optical fiber is used in high-bandwidth-network backbones. And it is easier to route through the crowded wiring ducts of offices that have computers. Unlike shielded wiring, which requires costly labor for installation, fiber often falls outside stringent fire-safety codes.

"Whenever big companies now pull cable [through an office or building], they are pulling in a lot of fiber," says Steve Lang, national account director at optical LAN installer Artel Communications Corp., Worcester, Mass. "Many companies are even installing fiber without a clear idea of exactly what it will be used for in the future."

Executives at Artel, which this summer introduced a new 200-Mb/s LAN based on fiber optics, believe that much of the recent movement toward lightwave data transmissions has been sparked by the continuing growth in optical links to computer-aided-design work stations. "Fiber cables are ideally suited for computer graphics," Lang maintains. "But once people find extra fibers are available, transmission systems are often expanded to include multiplexers attached to stand-alone dumb terminals through the entire area."

"Fiber fever" grabbed the spotlight at July's National Computer Conference, says Ernest M. Raasch, executive vice president of Codenoll Technology Corp., Yonkers, N. Y. "NCC was essentially a requiem for the computer industry," says Raasch, referring to the deep industry slump. "But there was plenty of interest in fiber-optic networks. It was definitely a 'fever' because it all whipped up since the 1984 NCC."

Codenoll, which is selling an Ethernet-compatible LAN based on edge-emitting LEDs, has seen a jump in requests for seminars on fiber-optics installations. "Every week, we see more requests. A year ago, you could have hardly found an engineer familiar with the 'flux budget'—the allowable system loss between nodes for a bit error rate of 1 by 10^{-9}," notes Raasch.

In industrial markets, fiber optics has garnered much attention lately—not because of lightwave speed but because of its immunity to electromagnetic interference and isolation from ground loops. Still, the factory-fiber segment trails office growth by two to three years, says Ray Coulombe, vice president of marketing at Eotec Corp., West Haven, Conn. Eotec—which markets an industrial link that can transmit at 25 Mb/s over 1 km—expects to see sharp growth beginning by 1988.

MARKET TO GROW TENFOLD ($ millions)

	1985	1990
Office	30	250
Specialized military	10	90
Factory	5	120
Vehicles	–	25
Other	5	15
TOTAL	50	500

SOURCE: ELECTRONICAST CORP.

Honeywell Inc.'s Optoelectronics Division in Richardson, Texas, plans a fall introduction for a low-cost version of its RS-232-C-compatible fiber-optics modulator-demodulator system for commercial markets. For about two years, the optoelectronic operation has been catering mostly to military data-link applications with its line of optical RS-232-C modems and multiplexers. Nonetheless, the company believes many potential data-communications applications are a number of years off.

AT&T SAYS 1986 IS THE YEAR

AT&T Co. is doing its part to further the lightwave revolution by adding to its local-area-network product line later this year, says Carl Sartfert, department chief of product planning for the lightwave components market, Allentown, Pa. AT&T Components & Electronic Systems began selling fiber optics to original-equipment manufacturers two years ago with a LAN system aimed at facility- and campus-wide networks up to 1 km in length. A year ago, AT&T beefed up its optical data-link product line so it could handle distances of 2 to 3 km and data rates from 1 to 220 Mb/s.

"AT&T has products that will take information across the country, the state, the city, a campus complex, a building, and even right inside the computer cabinet—with high data rates," says Sartfert. "And we do see a need for slower data rates as well." AT&T will likely preview some of its future LAN products at the upcoming Fiber Optic Communications and Local Area Networks Exposition in San Francisco, Sept. 16-20.

"There has been a lot of talk about the evolution occurring in the 1985 time frame. My opinion is that the effort has started but it is taking a little longer to develop products and make designers aware of it. The evolution will really take hold in 1986."

"You are not going to go out and knock heads with the folks in twisted pair just because you've got extended distances and so on. It's just not cost effective yet," explains Gary Null, Honeywell Optoelectronics sales and marketing manager. "We are, however, taking on bits and pieces within networks which are passing through harsh environments." Honeywell is using such an RS-232-C-compatible link to route mainframe lines from one side of its Richardson facility to a new gallium arsenide front-end processor at the other.

Four-year-old Raycom System Inc., Boulder, Colo., is offering low-cost lightwave modems based on its optoelectronic couplers that can transmit in two directions over a single fiber. The full-duplex fiber-optic systems reduce the cable costs. The patented couplers channel away the reflection of transmitted lightwaves from the modem's signal-receiving detectors. Raycom will soon begin selling the bidirectional lightwave couplers separately.

"We notice that people are generally trying to introduce fiber optics in a transparent way to the computer networks—in other words, where electrical cable is a problem," says Karel Kosman, founder and president of Raycom. "In five to seven years, people will start to use fiber optics to its full potential with computers. To do that they will rewrite computer communications software to networks with hundreds of megabits per second. A lot of software will have to be rewritten."

SOME SKEPTICISM. Some industry observers are less than optimistic that fiber-optic communication will take over in the nonvoice sector. For example, Stuart Lipoff, technology analyst in the Electronics Systems Sector of Arthur D. Little Inc., the Cambridge, Mass., market research company, believes optical fiber has lackluster prospects in the office LAN business. However, the immunity of lightwaves to electromagnetic interference could secure its place in many industry applications, he adds.

"The most interesting application relates to computer-aided design, where you might be running a photoplotter to create the final artwork for printed-circuit boards or integrated-circuit masks," Lipoff suggests. "Plotters might run 12 to 16 hours in creating intricate designs and the presence of even a single bit error at the last second could ruin the entire work. So the need for electrical isolation and EMI freedom is a major incentive to providing high-reliability data channels, even when you are talking short distances." ☐

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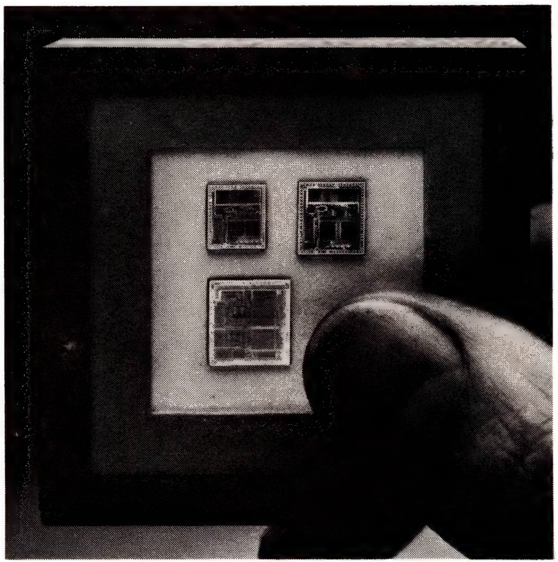
The MC68020 is already destined for great accomplishments. It seems likely it will be a major factor in the market for use in the next generation of robotics. Its potential for high speed graphics and advanced mathematics make it ideal for high volume data processing, complicated computer-aided design and manufacturing (CAD/CAM) processes and next-generation general purpose computers.



Our family portrait.

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IS THE POWER TUBE AN ENDANGERED SPECIES?

SALES HOLD STEADY, BUT R&D FUNDS ARE DISAPPEARING

by George Leopold

WASHINGTON

A vocal minority of engineers maintains that the power tube is still a technology with which to reckon. But many fear that rapidly declining funding for research and development could leave the technology stranded.

Proponents are particularly concerned about cuts in Department of Defense R&D funding to the industry over the past four years—from $18 million in 1981 to $8 million by year end. If the trend continues, they warn, funding will drop to a mere 1% of procurement in the next two years. The consensus seems to be that funding above 4% is necessary to maintain a healthy industry. About 87% of tube sales go to the military.

HOLDING ITS OWN. The rise of solid-state technology in the early 1960s seemed to sound the death knell for power tubes. Solid state, the conventional wisdom went, would eventually replace electron-beam devices. But tube advocates argue that the technology is holding its own against solid state for several applications and, in some cases, is outperforming solid state.

"Technologically, there's a lot of vitality remaining" in tube technology, contends Robert K. Parker of the Naval Research Laboratory in Washington. "It's not a mature technology."

High power generation at high frequencies is almost universally cited as the primary advantage of tubes over solid state. "I think the power of solid state has peaked out," contends Victor Granatstein, a professor of electrical engineering at the University of Maryland, College Park.

Parker, who directs the Microwave and Millimeter-Wave Tube Technology Branch at the lab, is point man in the effort to increase R&D spending for tube technology at a time when the military's tube procurement has been steadily increasing (see chart). "If there is a mature technology, it is perhaps solid-state radio-frequency device technology because it, unlike tubes, is beginning to hit some natural limits," he argues. By contrast, Parker and others interested in tube development point out, tubes' power continues to grow at a rate of 10 to 20 dB per decade; solid-state devices grow at a relatively slow rate of only 3 dB per decade.

According to Electronic Industries Association estimates, the U. S. power-tube industry recorded sales totaling just over $1 billion in 1984. The largest single segment was microwave tubes, which accounted for $477 million. Industry officials expect such applications as space radars, electronic countermeasures, and satellite communications systems to push annual growth ahead 5% to 7% this year. Equally important, industry observers say solid-state devices are not replacing tubes as fast as had been expected.

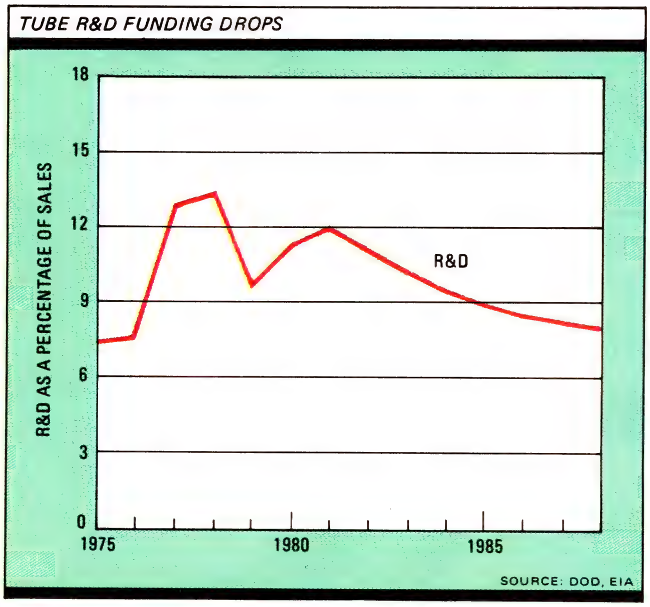
The limited research undertaken in the past several years has yielded significant improvements in tube technology. For example, research into new materials, such as samarium cobalt, has improved the performance of such devices as the magnetron. Samarium cobalt, introduced about five years ago, has reduced the size of magnets. In addition, the power-handling capability has made a two-decade leap in just 10 years, says Parker.

Though tube proponents concede that solid state has supplanted vacuum tubes at low power because of the inherent size advantage, they are quick to point out that tubes are now competitive in the midfrequency range with high power requirements.

BETTER TUBES. Improved reliability and efficiency have also helped restore the image of tube technology. Nearly all communications satellites and deep-space missions rely on traveling wave tubes (TWTs) for high-power microwave transmission. Typically, these tubes have efficiencies of 30% to 50% and usually operate for more than seven years, notes Thomas Schultz, an assistant product line manager with Raytheon Co.'s Microwave and Power Tube Division in Waltham, Mass.

The widely held notion that multiple solid-state devices would eventually replace a single bigger tube is frequently challenged by the advocates of tube technology. Parker acknowledges that in comparing the technologies, there is a wide gap between a single power tube and a single solid-state device, and that solid-state technology holds the advantage. "It comes down to, in many cases, how many single elements can you add together in solid state economically to compete with a large, single source. That answer isn't fully in."

TUBE R&D FUNDING DROPS



SOURCE: DOD, EIA

Chester Lob, vice president for engineering at Varian Associates Inc., Palo Alto, illustrates the engineering problem by citing a Westinghouse Corp. project aimed at replacing a very large tube in its SPS-40 radar with many solid-state devices. "The jury's still out as to whether it's going to be cost-effective," Lob asserts.

Lob, whose company is the world's leading manufacturer of vacuum tubes but also produces solid-state devices, maintains that the realization is slowly sinking in at the DOD that there is a place for both technologies. The guiding principle, he says, should be procurement of the best device for the application. "We see the technologies as complementary."

Because many of the best tube engineers are now close to retirement, training engineering students and industry employees to replace them is of special concern. "There is, I think, a legitimate concern about the creative vitality of the U. S. [tube] industry," Parker says.

Another worry: tube designers are retiring

To ease the expected shortage, the Pentagon established the Air Force Thermionics Engineering and Research (After) program at Stanford University in 1977. Four years ago, the engineering program was moved to the University of Utah at Salt Lake City.

Richard Grow, After program manager, describes the program as a cooperative effort between the tube industry and the Air Force's Air Development Center in Rome, N. Y. Annual government funding for the two-year program totals $650,000. About three quarters of the students graduating from the After program remain in the tube industry or a related field.

Among the research projects that are already under way at Utah is the development sponsored by the National Aeronautics and Space Administration of a backward wave oscillator that will eventually operate at 2 terahertz, notes Grow. (Other NASA projects include the development of 20-GHz space transmitters by Hughes Aircraft Co.'s Electron Dynamics Division and a 30-W 2.2-GHz telemetry transmitter for the Shuttle-Centaur project).

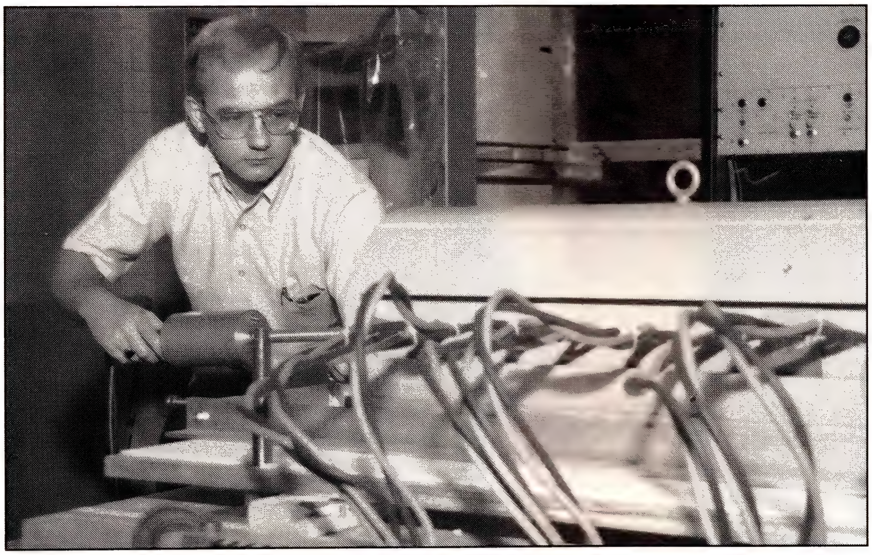
Grow estimates that about 20 students drawn from the tube industry will enroll in the After program this fall. Elsewhere, Maryland engineering professor Granatstein says he has about 25 graduate-level engineering students enrolled in his power-tube courses. Researchers are pursuing related but separate studies on microwave power generation using electron beams at Dartmouth College, Cornell University, the Massachusetts Institute of Technology, and the University of California at Los Angeles.

Tube technology's future looks secure, though unremarkable. "We're going to see incremental increases," says Robert Woods of Hughes. "It's not going to be giant strides." Raytheon's Schultz argues that such devices as microwave tubes may eventually find applications in such areas as fusion energy.

BROADER BASE. Along with broadening the tube industry's base to include more commercial applications, Parker argues that there will be a real need for enhanced capabilities, particularly for military needs. "A careful examination of the issues argues very emphatically that substantive increases in performance by orders of magnitude are going to be required."

Tubes, he says, can meet those needs. Meanwhile, commercial use, which accounts for only 13% of tube sales, would include not only plasma heating for fusion energy but TWTs for satellites and magnetrons for the Japanese-dominated microwave-oven market.

Aside from convincing engineers that tube technology is far from being over the hill, however, tube proponents want to persuade the industry that the electronics industry is big enough for both technologies. Says Parker, "In a very real sense, there's a role for both." ☐



MEASURING UP. Robert Parker of the Naval Research Laboratory, a leader in tube R&D, is shown making magnetic-field probe measurements on a solenoid magnet in a lab project.

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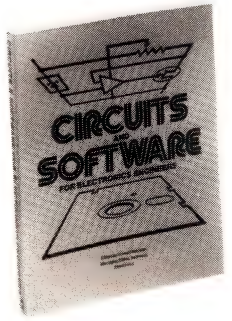

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ELSCINT LOOKS AGAIN FOR MAGIC TOUCH

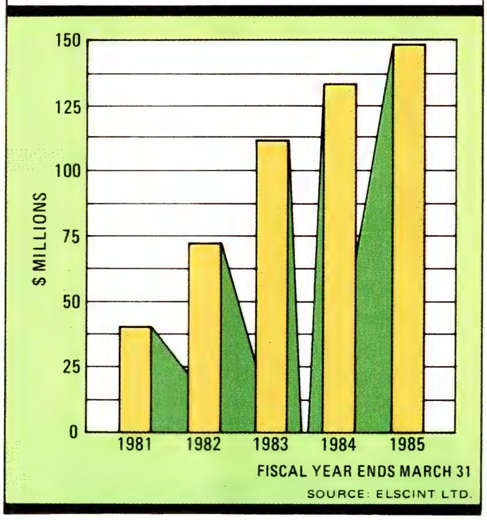
ONCE A HIGH FLYER, THE MAKER OF MEDICAL EQUIPMENT PAYS THE PRICE OF POOR MANAGEMENT

HAIFA, ISRAEL

Once known as one of Israel's leading high-technology companies, Elscint Ltd. has quickly lost its luster. A maker of advanced medical diagnostic imaging equipment, the 16-year-old Elscint grew spectacularly, then saw its growth come to an abrupt halt this year as it posted a whopping $33 million loss on sales of $147 million. The bad news continued in the first quarter of fiscal 1986: it lost $15.4 million on sales of $31.4 million (see tables).

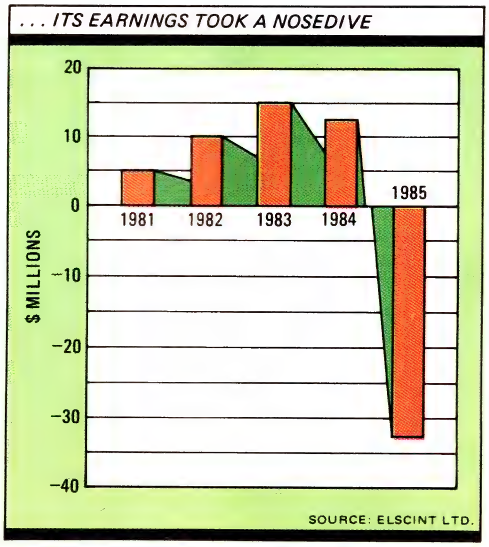
Now Elscint is struggling to trim its work force and consolidate its operations to stem the tide of red ink as it tries to compete with its larger competitors in the medical electronics equipment market. Some observers believe the company must also redefine its corporate philosophy.

WHILE ELSCINT'S SALES GROWTH SLOWED . . .



SOURCE: ELSCINT LTD.

. . . ITS EARNINGS TOOK A NOSEDIVE



SOURCE: ELSCINT LTD.

Whatever the company does, it has to move quickly. "The company is in severely troubled waters," maintains Joseph Millsap, who follows Elscint for L. F. Rothschild Unterberg Towbin in New York. "Elscint's ability to survive is a function of the decisions made by its senior management in the weeks and months ahead."

Though its troubles came in the midst of Israel's most serious economic crisis in more than two decades, they had little to do with the state of the Israeli economy. Most if not all of Elscint's woes can be attributed to poor management decisions and a change in U. S. regulations concerning the purchase of big-ticket medical equipment by hospitals.

Founder and chairman Avraham Suhami took the blame for the company's dismal performance and has since resigned from the company. He was replaced by Uzia Galil, who is also chairman of Elron Industries Ltd., a high-technology Israeli holding company with a 29% stake in Elscint.

As late as this winter, the company was still predicting sales of $220 million for fiscal 1985. And company executives had confidently predicted that sales would reach $500 million by the late 1980s. Based on this projected growth, Elscint set up new factories in Israel, Western Europe, and the U. S., and an international marketing network. "We developed the company too quickly, and our products failed to penetrate international markets as expected," Suhami noted recently.

Elscint produces a broad line of equipment in the medical diagnostic arena, with new products in all five major medical categories: nuclear medicine, computer-aided tomographic scanners, X-ray systems, ultrasound, and magnetic resonance imaging. The company has managed to carve out about a 10% share of the world medical electronics equipment market, competing with such heavyweights as General Electric, Philips, Siemens, and Toshiba.

Still, it is this philosophy of being all things to all markets that must change if the company hopes to right itself, analyst Millsap believes. "They have to buck the trend of the past, which was to run with the large companies in all segments" of the imaging market. He advocates that Elscint get out of the ultrasound and conventional X-ray market, because it can't realistically compete in these areas in terms of price.

Benyamin Sabbah, president of Elscint (Israel), the group that coordinates sales operations in Israel and abroad, attributes the company's slowdown to the situation in the U. S. market, which acounts for two thirds of Elscint's sales. He believes the company is feeling the impact of an October 1983 change in Medicare reimbursements for expensive medical gear, such as CAT scanners. That in turn led hospitals to reduce their outlays for medical equipment. In addition, Elscint ran into stiff competition in Europe from Siemens AG and Philips, where its dollar-linked products were overpriced.

But serious mistakes by company management hurt just as badly. Among the most critical was the decision to purchase Xonics Inc., a U. S. marketing company. Shortly after the $15 million purchase in late 1983, it became clear that Xonics was in an advanced state of financial decay. Efforts to turn Xonics around have sapped Elscint's financial resources.

OVEREXTENDED. Industry sources say the blunder was symptomatic of then-chairman Suhami's determination to expand as rapidly as possible; thus when the market declined, Elscint was greatly overextended. Elscint now faces a major reorganization over the next few months, which will probably include laying off several hundred of its 3,000 workers in Israel and abroad.

In an attempt to slash costs, Elscint plans to buy back the shares and debentures offered by its subsidiary, Elscint R&D Ltd., which was formed under a tax-shelter law enacted for local high-tech companies. Elscint raised some $70 million in Israel over the past two years using this program. Now, however, the interest payments on the debentures are costing it far more than it originally budgeted.

Company officials claim the move won't affect Elscint's R&D activities. As a senior Elscint official notes, "without R&D, a company like this is dead."

Some of the fruits of Elscint's research were born earlier this year when it entered the magnetic-resonance-imaging market. Elscint claims to have 20 firm orders for its Telsa line, though it still awaits approval of the products by the U. S. Food and Drug Administration.

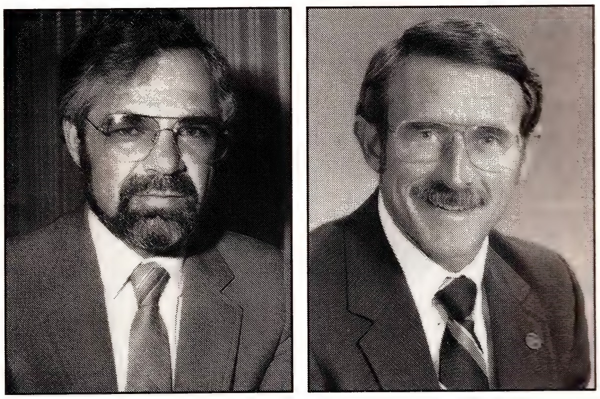
Chairman Galil is confident that Elscint will weather the storm and emerge from its current troubles revitalized. He notes that "crises tend to occur in fast-growing high-tech industries with many such companies undergoing a bad year or two."

Rothschild's Millsap believes that "all the characteristics required for [Elscint's] survival are in place. They have a strong parent and strong senior management bolstered by Elron. They know that there are hard decisions to be made." *–Neal Sandler*

BOEING DIVISION MAKES OWN MARK

SEATTLE, WASH.

Boeing Computer Services, long the dutiful child of Boeing Co., is emerging from beneath the wings of its parent. The division's diverse work in the last few years—notably on communications standards to connect Boeing's own collection of factory and office hardware—has brought Computer Services recognition from standards organizations, customers, and vendors who see value in open systems.



ON TARGET. Sheldon Blauman (left) and Jerry L. Probst want to expand the horizons of Boeing Computer Services.

Supporting Boeing's prodigious $550 million computing power is still the division's No. 1 priority. But its burgeoning Commercial Services Group offers everything from timesharing on a Cray Research Inc. X/MP to spreadsheet software and an Advanced Technology Applications Division devoted to communications standards for hardware.

Recognition is hard-won for a unit barely mentioned in Boeing's annual report: Computer Services is part of Boeing's "other" operations. The Bellevue, Wash., division's revenue is a small part of Boeing's $10 billion annual business, despite its enviable accomplishments—early this year, for example, the division landed a $215 million contract with the National Aeronautics and Space Administration for an integrated services digital network.

Computer Services also packages microcomputer software, such as three-dimensional spreadsheets and computer-based training systems, and programs that let companies with a variety of hardware create their own multivendor systems. But the unit is not apt to burst onto any market with fireworks. "We want to grow at a manageable rate," says Jerry L. Probst, its director of business planning and control. "We don't want our appetite to get bigger than our ability to provide services."

There is one area, though, where it is willing to let its appetite get big. At this November's Autofact, the factory-automation show in Detroit, the division will join General Motors Corp. to demonstrate GM's Manufacturing Automation Protocol with Boeing's Technical/Office Protocols (TOP). TOP is designed to run in the office, connecting with MAP through the factory. This project will include hardware from 20 vendors, plus Computer Services, which will implement TOP on a microcomputer.

"We're certainly hoping it will be the big splash," says Laurie Bride, Computer Services' manager of advanced data-communications technology and program manager of the MAP-TOP program. She discounts critics who call MAP or TOP a "hammer" to force vendors into conformance.

"Its rigidity seemed to be necessary to get initial product implementations of OSI [the open-systems interconnection reference model]," Bride says. "It got the vendors off the dime. They were all planning on OSI, but when you get a lot of technical experts in the same room, you'll never get two opinions the same. By detailing the specifications, we eliminated those arguments."

Boeing's Sheldon Blauman, manager of Network Architecture Planning for the Advanced Technology Applications Division, plans to publish three papers this summer on OSI protocols—a nontechnical architectural overview for the office only, a list of technical specifications for implementing existing protocols, and tentative specifications for future implementations of such features as graphics and voice communication.

Blauman notes that a complete network architecture must include factory, office, and data center—data centers being primarily IBM Corp.'s territory with its Systems Network Architecture. Boeing's work with data-center protocols centers on establishing migration paths through SNA. *– Denise Caruso*

BOTTOM LINES

TEXAS INSTRUMENTS BUYS 15% OF AI FIRM

Texas Instruments Inc., Dallas, has bought a 10% share of Carnegie Group Inc., Pittsburgh, for an undisclosed amount of cash and equipment credits. Carnegie Group, a privately held company that specializes in artificial intelligence software, will use the credits to buy TI computer hardware and software. TI also signed a three-year general license agreement with Carnegie under which TI will fund research and development projects for AI software. TI, in turn, will have the right to distribute Carnegie Group's technology and products internally. "Our relationship with Carnegie Group exemplifies TI's long-term corporate commitment to artificial intelligence technology, including the manufacture of AI hardware and software to provide specific solutions to customer problems," said TI executive vice president Grant Dove.

LISP MACHINE RAISES $12 MILLION

Lisp Machine Inc. has raised $12 million through a fourth round of venture financing. The Los Angeles company supplies hardware and software tools for artificial intelligence research and applications. "A financing of this magnitude, in an investment climate where financings above $10 million are quite rare, speaks volumes about the investment community's confidence in our potential and our approach to AI," said company chairman Ward D. MacKenzie.

SIGNAL ACQUIRES COMPUTER MAKER

Signal Technology Corp., Boston, has acquired Pacific Microcomputers Inc., San Diego, a maker of single-board computers with VME and Multibus architectures and Unix operating systems and software. Terms of the agreement were not disclosed. Privately owned Signal Technology has operations in selected components and subsystems markets.

SIEMENS BUYS INTO RELAY MARKETER

Siemens Capital Corp., Iselin, N. J., the shareholder for the U. S.-based companies of Siemens AG, Munich, has acquired 80% of Bloxcom Corp., a Wheeling, Ill., marketer of electronics and electromechanical relays. The acquisition is valued at about $1 million. Bloxcom will operate as a separate Siemens U. S. unit and serve as the nationwide marketing arm for Siemens relays.

WASHINGTON GOVERNOR BUILDS HIGH-TECH TEAM

OLYMPIA, WASH.

When RCA/Sharp Microelectronics Inc. decided to locate its new $200 million wafer-fabrication plant in Camas, Wash., it was a vote of confidence in Gov. Booth Gardner's plan to attract new industry to the Evergreen State.

AGGRESSIVE. Gov. Gardner talks up Washington's attractions.

"I'm using a full-court press to attract out-of-state companies," says the first-term governor, who is fond of sports terminology. The RCA/Sharp coup [*Electronics-Week*, July 1, 1985, p. 17] is particularly gratifying to Gardner, a Democrat, because part of the reason for his upset victory last year over the incumbent Republican was the state's unemployment rates. In some areas, unemployment approaches 20%, making Washington one of the most economically depressed areas in the nation.

Gardner, 49, is an heir to the Weyerhaeuser timber fortune and a graduate of the Harvard Business School. Between serving in elective jobs—from state senator to county executive—he served as president of Laird Norton Co., a building and supply company associated with Weyerhaeuser Co.

BUILDING A TEAM. Making economic development a keystone of his administration, Gardner doubled the state's economic-development budget to $20.8 million and established an economic-development cabinet consisting of many of his department heads. All this is part of his Team Washington concept, which he put into operation just 20 days after his inauguration last January.

The team plan includes an attractive package for industry. Among the features designed to entice out-of-state manufacturers to relocate in Washington are a deferred-tax plan, which calls for a three-year moratorium on sales taxes for construction and equipment, with a five-year payback and the establishment of a state loan fund of up to $350,000 per project for any "worthy" new business venture.

The state has allocated $15 million from its capital budget for the Community Economic Revitalization Board to install such support facilities as roads and water and sewer lines for new job-producing private investment. Gardner also plans to allocate funds to train workers for high-tech jobs.

Gardner believes that his deferred-tax plan was instrumental in persuading RCA/Sharp to choose Washington over other areas. RCA/Sharp's decision was something of an upset—the smart money figured the company would construct its highly automated plant in Portland, Ore., just across the Columbia River from Camas. The prize is 600 jobs for highly skilled and well paid workers.

Gardner isn't finished. "The ball is in my court," he says as he discusses his pursuit of Pacific Rim business. He traveled to Tokyo a few weeks ago, where he spoke with representatives of 15 Japanese companies, and also visited with officials from China and the Soviet Union.

Gardner plans to return to Japan in October, even as he and his assistants hungrily eye potential dropouts from California's Silicon Valley as well as those from neighboring Oregon's "Silicon Forest." *–Robert McCluskey*

NYU PROFESSORS WORK IN PARALLEL

NEW YORK

University researchers spend most of their time working in relative obscurity. But when IBM Corp. declared it was taking a leap into the parallel-processing pool two weeks ago, New York University professors Malvin Kalos and Allan Gottlieb quickly found themselves in the media spotlight as the men behind NYU's Utracomputer project.

The Ultracomputer, in turn, is the machine behind IBM's high hopes for its Research Parallel Processing Project, RP3 [*Electronics*, Aug. 26, 1985, p. 16]. In fact, the Ultra project is a subcontractor for software development for IBM in its proposal for funding from the Defense Advanced Research Projects Agency.

Professors at NYU's Courant Institute of Mathematical Sciences, Kalos, 57, a physicist, and Gottlieb, 40, a mathematician, came to Ultra from contrasting backgrounds. And each brought his own area of expertise to a program that began in 1979.

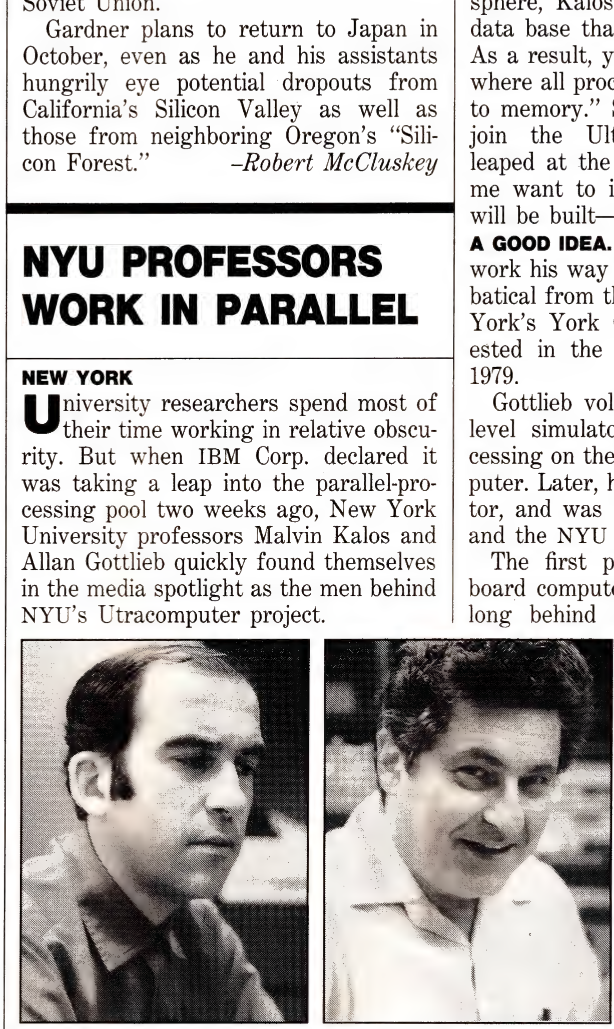
Kalos was invited to join the program because of his experience with extremely complex Monte Carlo computations—a powerful numerical-calculation process by which a random process is simulated. He had spent nine years in private industry studying and designing nuclear reactors. He provided the project with the know-how and point of view of someone who uses the most powerful computers available to solve highly complex mathematical equations.

To compute problems such as tracking the radiation flow from a reactor through a shield and into the atmosphere, Kalos says, "you need a large data base that tells how matter reacts. As a result, you need a parallel process where all processors have shared access to memory." So when he was asked to join the Ultracomputer project, he leaped at the opportunity. "People like me want to influence how a computer will be built—how it will work."

A GOOD IDEA. Gottlieb, however, had to work his way into the program. On sabbatical from the City University of New York's York College, he became interested in the Ultracomputer project in 1979.

Gottlieb volunteered to write a high-level simulator to mimic parallel processing on the institute's CDC 6600 computer. Later, he would refine the simulator, and was invited to join the project and the NYU faculty full-time.

The first prototype, a pair of one-board computers working in tandem, is long behind Kalos and Gottlieb, and their second eight-processor Ultra, the Ultracomputer 201, is now in the engineering stage. The pair expects to complete a 32-processor model with a custom very large-scale integrated-circuit network in two years. *–Tobias Naegele*



ULTRA. Professors Allan Gottlieb (far left) and Malvin Kalos direct the NYU Ultracomputer project.

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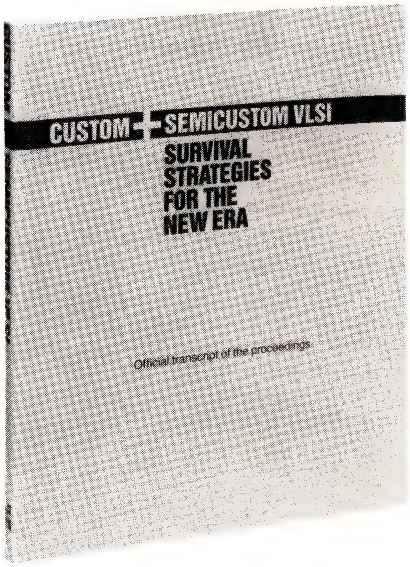
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BIGGER BAG OF TECHNOLOGY SHARPENS MACHINE VISION

SYSTEMS OFFER ADVANTAGES DESPITE COST AND COMPLEXITY

by David M. Weber

The drive to automate more industries is focusing increased attention on machine vision as manufacturers push the state of the art of this promising technology. Automated systems that have some sort of artificial sight are finding applications ranging from simple inventory control and pick-and-place operations to complex production and inspection tasks. Projections for market growth and future developments give strong indications that machine vision will before long become essential to factory automation.

The technology of vision, however, is newer and more experimental than other recent technologies in this area, such as robotics and ruggedized local-area networks, because it involves trying to imitate a complex aspect of human perception that is still not fully understood.

Current machine-vision systems are not sophisticated enough to perform a wide range of identification tasks: they must be tailored to the demands of each application. The manufacturer considering machine vision therefore needs to identify what aspects of his factory-floor process—from sorting parts to full assembly—might be implemented with machine vision and match them with the techniques that best suit his needs.

Among these techniques are binary imaging, local windowing, gray scaling, edge detection, three-dimensional imaging, and pattern recognition. A number of U.S. companies address these techniques in different ways and offer specialized products designed for the end user.

Machine-vision technology has two major focuses. The first is automated inspection of components or finished parts, and the second is automated guidance of robots on the production line or for inventory handling, accounting for about 90% and 10% of the market, respectively. A slight narrowing of that ratio is expected over the next decade.

Currently, about 10% of U.S. factory workers are involved in some aspect of product inspection, but vision companies agree that about half of them could be replaced by automated inspection equipment by the middle of the next decade. Machine vision's share of the robot-sensor market is growing: about 25% of all robots installed during the next decade are expected to incorporate some kind of vision system. However, robot manufacturers are wary of the expense of incorporating vision into their machines, and are for the most part drawn to less costly sensor technology as an alternative [*ElectronicsWeek*, Feb. 18, 1985, p. 22].

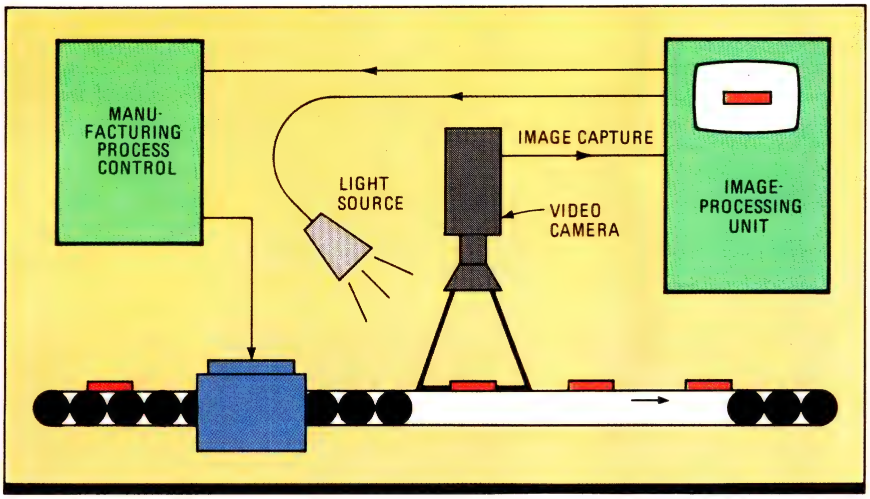
Vision is complex and expensive to achieve artificially. Processing a detailed visual image is difficult because of the high spectral frequency of the image's features; even the simplest image contains an enormous amount of information.

In most industrial machine-vision applications, an image can be filtered to provide only the information that is of interest: the correct diameter of the holes in a printed-circuit board, for instance. The practical goals for machine vision have in fact focused on relatively simple tasks.

1. ECONOMICS. Videk's Kahwati says a small boost in yield can offset machine vision's cost.

Sensory mechanisms such as piezoelectricity and ultrasonics are often cheaper than machine vision and thus preferred by manufacturers for rudimentary mechanical guidance. But vision is the better method for an intelligent machine that must do more than just move parts but also make judgments about their placement on an assembly line or decide to accept or reject a part at a quality-control station.

Vision in turn is the most demanding of a machine's intelligence. It is far more expensive and time-consuming to teach a robot to identify an obstacle in its operating environment than it is to install an ultrasonic warning sensor at the end of the robot's arm that simply avoids the obstruction. If the intent is not to avoid the object but to grasp it, a piezoelectric pad on the arm's gripper may be the technology of choice. But if the object must be both identified and manipulated with precision (or discarded if found defective), then vision has to be a serious consideration for the manufacturer.



2. ON LINE. Machine-vision inspection systems must closely coordinate a number of elements, each of which has different operating parameters in the manufacturing process.

Suppliers of vision equipment are of course quick to encourage industrial and electronics manufacturers to adopt their technology. Videk Corp., Rochester, N. Y., a machine-vision spinoff of Eastman Kodak Co., suggests that if a 1% or 2% yield improvement results in at least a $100,000 saving in manufacturing costs, then machine vision can be justified. The nominal result: a payback period of about a year.

"Even if the payback period is longer, machine-vision systems can spot production problems early, and this information can be used to reduce waste and rework, maximizing uptime," says Gus Kahwati, Videk's president (Fig. 1). A major goal of machine vision is to eliminate the need for statistical methods to monitor performance on the factory floor by being able to look at the actual processes. Tool positioning, tolerance adjustments, and defect detection can be accomplished in near-real time—a compelling reason for many manufacturers to consider artificial sight for their operations.

WHAT PRICE MACHINE VISION?

Machine vision can cost from about $150,000 for a fully configured vision-capable robot, to $50,000 for an automatic inspection system that uses vision. And there are conflicting estimates about whether and how rapidly these prices will fall. One company, Tech Tran Corp., a market researcher in Naperville, Ill., projects an average system cost for machine-vision inspection to fall to about $19,000 by 1994. But as with any infant industry, market projections are often a question of how the technology in question has been defined.

Matthijs Moes, machine-vision project manager for International Resource Development Inc., a Norwalk, Conn., market researcher, expects the machine-vision industry to expand the way much of the rest of the electronics industry has expanded: by passing savings from declining hardware costs on to the customer, thereby increasing sales volume and revenue. The vision industry is new, however, and a quantitative forecast of decreasing prices is difficult to make because there is little past experience from which to extrapolate.

Videk's Kahwati stresses that "unit costs can be very deceiving because the market is so broad; virtually every piece of [vision] equipment is application dependent. You might be able to come up with some figure for an average price per unit—and you might even make a projection about how that figure will fall. But the range of capabilities for machine-vision equipment makes any discussion of average cost meaningless, even for a single industry."

At the low end, simple inventory control should account for an increasing share of sales for Videk and other vision manufacturers. It is relatively easy, for example, to store a template of part numbers in image-processing hardware and then match them with the parts to be inspected as they move down a conveyor. If the vision customer has the equipment on hand to control the parts' orientation so that only their numbers need be recognized, nothing more than simple bit-mapping algorithms are required from the vision supplier. Pixels from the stored template are matched with the numbers on a part, and the part is passed or rejected on that basis.

The challenge is greater if there is less control on the factory floor and if the manufactured item has not been precisely tagged. Ambient lighting in a factory always varies, and in most instances there are subtle changes in the way objects are oriented with respect to a vision system. In addition, the numbers or characters used in product marking may vary enough to vitiate a 1:1 pixel match with a stored template. Any or all of these variations greatly complicate the job of the machine-vision supplier, and require complex pattern-recognition algorithms and the hardware to process them. At the very least, they require a powerful computer and good lighting (Fig. 2).

Instead of translating complex algorithms into working systems, however, most machine-vision suppliers have decided to produce equipment based on the technology at hand. Because their potential customers in industry want functional, inexpensive equipment, the vision people stress simplicity (Fig. 3).

Most vision systems already at work in industry use binary imaging—sometimes known as "blob analysis." This is the simplest form of object recognition, whereby an electronic camera (usually a charge-coupled-device type because it is inherently more rugged than a Vidicon tube) is connected to a processor that counts dark and light spots in its field of view and assigns a value of black or white to all pixels below and above a certain intensity.

Such an approach is usually adequate for object detection, and is therefore an appropriate technology for robot guidance—where the robot only has to know whether an object is there and if it should be moved. Binary imaging is also appropriate to some forms of inspection: if things simply have to be counted for a determination or presence or absence.

In the electronics industry, for example, serial numbers on silicon wafers can assist in identifying parts that would be difficult to distinguish from one another if subtle morphological features had to be detected. Similarly, a broken part can be detected by observing missing pixels in an image, which would show up as a white space where light passes through undeflected.

3. EASY TO USE. Because most customers want inexpensive equipment, vision companies are stressing simplicity.

In another common technique called local windowing, different threshold values are assigned to different areas of a scene. This approach lets certain areas get special attention by blocking out features that do not have to be inspected. Because the scanning rate of a camera is tied to the line current, an image can form from 30 to 60 times a second, and the image preprocessor (typically a microcomputer) can capture and digitize a given area of interest quickly enough to be of value even on a rapidly moving assembly line. The result, as in other approaches to machine vision, is an array of pixels that represent a light-intensity distribution over a defined area. The preprocessor then stores this array in memory until the image processor can analyze it for a user-defined set of features.

Local windowing is limited in that it cannot detect the boundaries of three-dimensional features unless the light source is precisely controlled to give an exact shadow configuration—an exceedingly difficult requirement on the factory floor.

The most advanced technique currently available for product inspection involves gray scaling, which processes each pixel by assigning it a value from 1 to 256. This number of gradations, however, demands greatly increased image-processing power compared to binary and local-windowing techniques: a standard 256-pixel array with up to 256 different light values per pixel requires over 65,000 8-bit storage locations for analysis. At a picture rate of 30 frames/s, the rate of picture analysis can lag behind the rate of image generation, making real-time applications impossible.

AT THE EDGE OF PERCEPTION

Fortunately, most objects on an assembly line are similar enough to one another that a complete analysis of each image is not necessary; a template of the object's gross shape can guide the system in analyzing certain required features. In addition, a full 256 gradations of light have not been proved essential for most industrial inspections; most gray-scale imagers on the market assign only 64 gradations per pixel, corresponding to the intensity of light transmitted by the camera. This is adequate to detect (if not necessarily identify) the shadows and edges caused by raised features without requiring precise adjustment of the ambient light.

Many vendors that purport to offer gray scaling do not, in fact. As a new technology, machine vision has generated terminology that is still loosely defined. Techniques whereby more than two black/white binary threshold levels are programmed into an image processor are sometimes called gray-scale capable. The difference is that the final image is still black and white, even though there is a slightly more subtle determination of what features are called black or white.

One vision company that offers genuine gray-scale inspection equipment is Itran Corp., Manchester, N. H. Its main product, the Itran 8000, uses 6 bits to resolve an array of pixels (up to 1,024 by 1,024 pixels in the high-resolution mode) into 64 gray-scale intensities. These are processed by a Motorola 68010 according to the pattern-recognition algorithms that Itran adopts for the needs of its users—many of whom are in the automotive industry.

But gray scaling is fairly well established, says company president Stan Lapidus; the customer only has to be willing to pay for it (about $50,000 for the complete Itran system). "The real challenge is edge detection, which is a much more complicated issue than gray scaling because it is so difficult to quantify," says Lapidus.

Even the question of how humans recognize an edge has not been resolved to the extent that an adequate edge-detection algorithm can be written. Itran, for example, has restricted itself to using well-established algorithms. While not providing automatic edge detection, they do give the user some flexibility in defining which edges the machine should look for in the object he wants to inspect.

Lapidus points out that most edge detection is a response to abrupt but often subtle light changes at an edge. But to duplicate this essentially intelligent process in an artificial-vision system requires very precise control of the light source, since any 3-d object, even a sphere, will show different patterns of dark and light as the light varies.

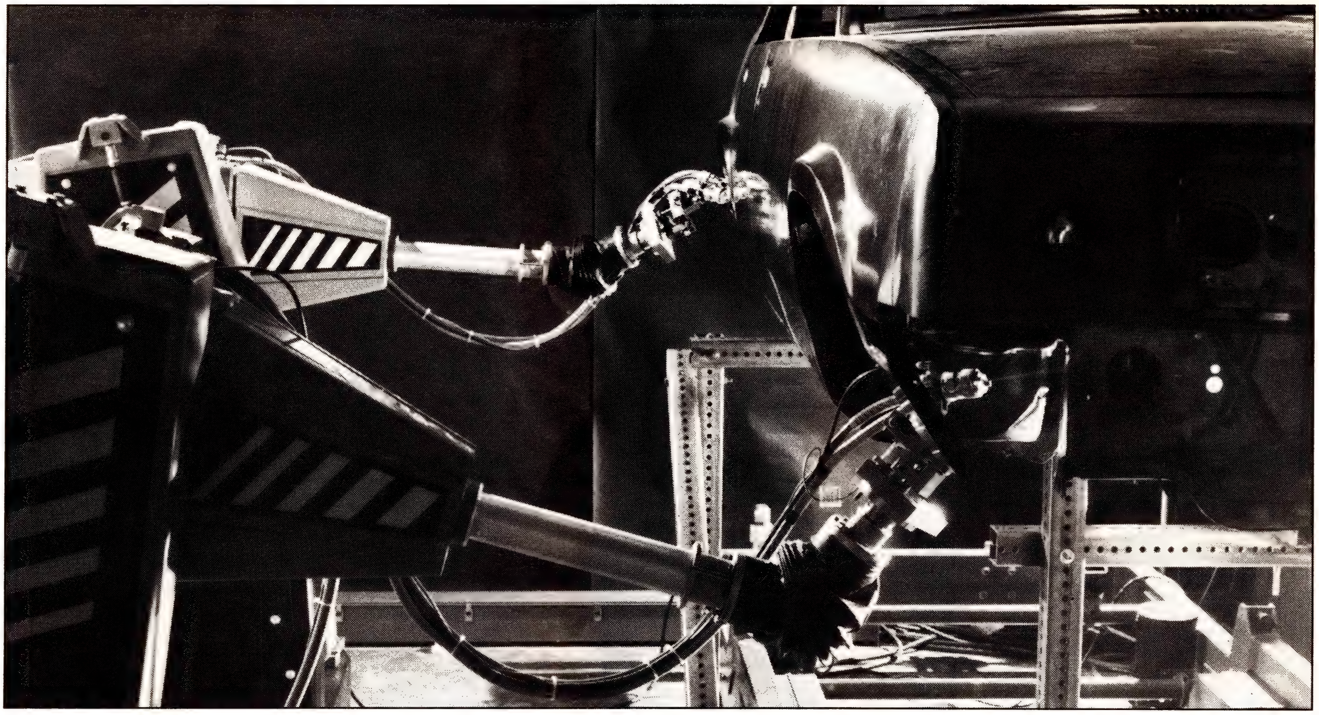
To account for all the possible changes in an object's appearance due to light variation places exorbitant demands on an image processor. The development of light-insensitive image analysis is therefore one of the major unresolved issues among machine-vision designers.

Most suppliers of high-end vision equipment claim some ability to accommodate changes in ambient light—usually by performing additional operations in the preprocessing stage to reduce demands on the processor's memory. Light-insensitive edge detection, for example, can be facilitated by a Fourier analysis that breaks down an image into its sinusoidal components—permitting each image wave to be acted on separately. An image can thus be enhanced if its edges are blurred or lacking in contrast. Background noise is also reduced because only the object's image undergoes the preliminary analysis.

Run-length encoding is another common technique for edge detection. This approach notes the transition points from black pixels back to white, and counts the intermediate (or gray) points between them. When this information is sent to the image processor, the actual analysis of the image has a starting point from which it can recognize an edge—either from a stored template or from the points defined by the user.

A similar approach, designed for robotic guidance rather than inspection, is used by Visitronic, Littleton, Colo., a division of Honeywell Inc. Detection of the

The most advanced available inspection method is gray scaling



4. TOP MARKET. Auto makers currently buy the most vision-guided robots. Electronics and other industries are expected to catch up.

outside edges of solid objects piled in a bin is accomplished by a relatively simple technique called photometric stereo that bypasses complicated image processing and relies on structured light to guide a robot's hand to its particular target in the factory as preprogrammed by the user.

Visitronic also uses the photometric technique to construct a three-dimensional-imaging system. The technique simply measures the brightness of light reflected from given points on an object's surface to specify the orientation of the object. Points of equal brightness are interpreted as concentric circles that become wider as the light's intensity diminishes with distance—thereby providing positioning information.

A second brightness measurement (from another light source at a known angle to the first) is then correlated with the original measurement to give a unique pair of gray-scale intensities. The computer can then build the relative position of both bright and dim points on the gray scale into a crude 3-d image, where the z-axis represents brightness.

TURNING TO 3-D

"To be practical in today's factory environment, it's not necessary for a 3-d system to mimic human capabilities or even to have elaborate artificial intelligence," explains Paul Hasler, manager of industrial marketing at Visitronic.

Imaging Dimensions Inc., Tucson, Ariz., has developed an even cheaper technique for 3-d imaging [*ElectronicsWeek*, Sept. 3, 1984, p. 31]. It bypasses not only AI algorithms, but also digital image processing. Instead, it models analog waveforms corresponding to gray-scale differences in two dimensions, with analog depth cues modeled separately as a third dimension. For example, reflected light is less if an object is far away; an object seems to move faster if it is closer; and a line of known dimensions placed at a known distance from the imager obscures the object in a quantifiable way.

"Any of these cues offers good resistance against the stresses that vision equipment might encounter in a factory, such as dust and [electromagnetic] interference," says Susan Gerves, Imaging Dimensions' president. "And because they don't require sensitive computers to interpret them, a small shop will save money by not having to buy an expensive processor to digitize an image."

Most machine-vision systems currently in use are in low-end applications such as inspection and light assembly. Automatix Inc., Billerica, Mass., is aiming higher, targeting the emerging market for surface-mounted-device assembly and inspection. Though 1984 was a dismal year for the company, a new thrust into advanced vision equipment is generating sales.

"It's about time somebody bet the ranch," says Jim Field, electronic products manager at Automatix. "U. S. industry has to automate or go offshore. Fortunately, SMD has eliminated the second option. Those devices can't be manufactured without automation, so it's best to leave the plants in this country where we have the know-how."

Field also stresses that the early pattern-recognition algorithms (such as the ones developed at Stanford Research Institute—now SRI—which have become a quasi-standard for the industry) are no longer sensitive enough for the modern automated factory and have to be redefined. Especially in the assembly and inspection of ever-smaller electronic components, precision is vital.

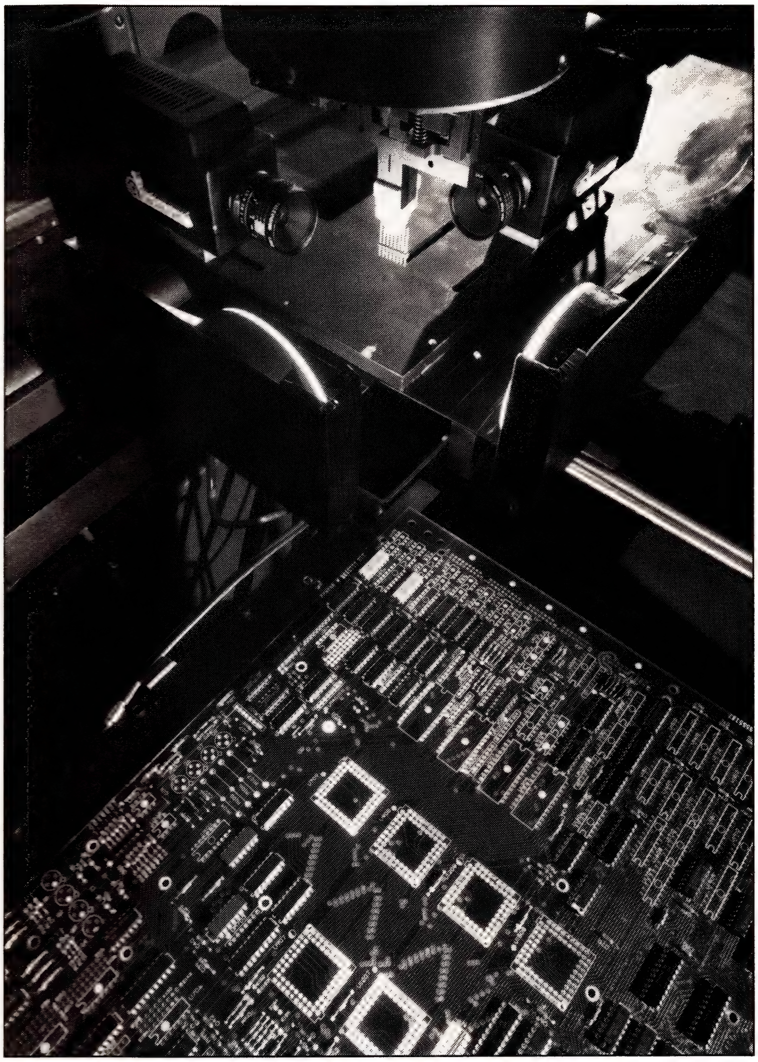
"Vision is the only way to go in the electronics industry," says Field. "That's the technology that offers the biggest potential for refinement. Tactile sensors won't be made sensitive enough, or have a fast enough error-recovery time, to be of use in the SMD area."

Edward Kornstein, vice president of research at ORS Automation Inc., Princeton, N. J., also stresses the vision industry's need for higher-level algorithms than those developed for pixel matching. "Packet-switching using parallel processors may be the way to go," says Kornstein. "The advantage is that different algorithms would work on the same piece of vision equipment. A user could choose, say, edge detection, color, part number, etc. depending on what he wants to recognize and how much he wants to spend."

Old pattern-recognition algorithms are not sensitive enough today

ORS's most recent product line is centered on its 68000-based Flexvision Image Computer that does a number of jobs, depending on the associated cameras and software. Among them are insertion guidance for populating a printed-circuit

5. LOOK CLOSELY. Printed-circuit boards offer one of the best potential applications for automatic inspection.



board, inspecting the board's components once they are inserted, and gantry-robot guidance for the palletization of larger parts such as packing crates.

Currently, the most promising use for ORS's products is in the automotive area. Saab-Scania Combitech AB has a license agreement to manufacture and sell Flexvision products in Europe and the UK, and to develop automotive applications for vision equipment in general, which it will share with ORS. This agreement is similar to the much-talked-about Automatix agreement with GM [*Electronics Week,* Aug. 6, 1984, p. 24].

The automotive industry now accounts for about 30% of the vision market (Fig. 4); the electronics industry follows with 20%. By 1994, according to the Tech Tran survey, each industry should have a market share of about 25%, because other markets will grab larger shares of the total.

Another promising place for machine-vision vendors is on the farm [*Electronics Week,* March 25, 1985, p. 32]. Examples under development include systems for detecting bruises on fruit, produce sorting according to shape, automatic identification of seedlings and weeds, and as a guidance mechanism for agricultural machinery.

The Automated Vision Association, a Dearborn, Mich., trade group that promotes the industrial use of the new technology, claims there were about 2,500 machine-vision systems installed in the U. S. at the end of 1984, with new installations proceeding at an annual rate of about 1,500 in 1985. Next year should see an additional 2,250 units added in the U. S.—a growth rate of 50%. If this pace holds, there will be an installed base of nearly 200,000 systems by the mid-1990s in a wide range of industries.

World figures are hard to come by, but in the area of machine vision—versus robots that do not necessarily come equipped with any artificial sense—the U. S. is in the lead and may well stay there. Moes of International Resource Development says U. S. vendors do not seem likely to be displaced by the Japanese.

"Advances in U. S. signal-processing technology, derived in part from military-supported R&D and the Very High-Speed Integrated Circuits program, seem likely to keep the U. S. out ahead for some time," says Moes. He believes that partnerships between U. S. and Japanese vendors (such as General Motors Corp. and Fanuc Inc. combining to form GMF Robotics Inc.) result in a two-way technology transfer: the Japanese get U. S. vision expertise; the U. S. gets Japanese hydraulics and precise robotic positioning.

LOOKING TO THE FUTURE

Estimates vary, but there are about 60 machine-vision companies (or machine-vision spinoffs from other companies) currently vying for a market of about $100 million. This is too many, even with the robust growth forecast for the industry.

"Delays in customer acceptance and payment will be the death of some small companies," says Moes, "as will the extensive custom engineering required for all but a few vision systems." Also, big companies with enormous resources for R&D and production are getting into the act, inevitably pushing out the smaller companies. Moes cites, in addition to GM/Fanuc, General Electric Corp. (with its own robotics and vision operations), and IBM Corp.'s venture with Sankyo-Seiki.

Finally, new technological developments—which always have their greatest effect on infant industries—will push out some players while bolstering the position of others. Developments to watch in vision-system advances include:

- Color and multispectral sensing, especially for color-coded part identification in factories and produce inspection in agriculture. Some prototypes already have multispectral capability, but none are commercially available because of the high cost of interpreting the resulting variations in the captured image.
- Overlap detection, to give a robot greater flexibility in bin-picking applications, and an operator more freedom in orienting parts for inspection. Many companies claim that their robots already have this capability, but no one is claiming it for parts inspection, which is by far the larger of the two markets.
- Visual servomechanisms that accept commands directly from the image processor to provide real-time control of robot positioning, and give automatic error corrections in such applications as printed-circuit-board manufacturing. (Fig. 5). Currently, vision systems perform these functions outside the robot-control loop. VHSIC processors will probably be fast enough to make in-loop vision control feasible when they are eventually adapted for civilian applications.
- Standardized software. Forth seems to be the language of choice for many of the newer vision systems because of its flexibility and ability to handle a number of tasks (such as image capture, image interpretation, robot guidance) simultaneously. Some software houses, such as Polyforth in Hermosa Beach, Calif., offer applications packages, but they require a lot of custom programming before they'll run. A vision package analogous to Wordstar or Lotus 1-2-3 would spur industry acceptance. ☐

MULTIPROCESSOR MAKES PARALLELISM WORK

BUS, EFFICIENT CACHE, I/O CONTROLLER KEEP THE PROCESSORS BUSY

TECHNOLOGY TO WATCH is a regular feature of *Electronics* aimed at providing readers with exclusive, in-depth reports from companies around the world on important technical innovations. It covers significant technology, processes, or developments incorporated in major new products. The reports also provide analyses of technical data, so that readers can assess the impact of new developments. Russ Moore, Tony Anzelmo, and C. Gordon Bell participated in the design of the Encore Multimax multiprocessor computer described here.

Designers at Encore Computer Corp. have created the latest example of a new class of microprocessor-based computers that outpaces midrange superminicomputers, yet comes at a much lower price. Encore's Multimax does this with a new multiprocessor structure that offers a high degree of parallelism and a modularity that permits a user to extend the basic architecture by adding boards to the computer.

Multimax can include up to 20 microprocessors on 10 dual-processor cards. The machine is built around the National Semiconductor Corp. 32032 processor, which is rated close to the performance of one VAX-11/750—about 0.75 million instructions/s. Therefore, a Multimax system's rating can range from 1.5 to 15 mips.

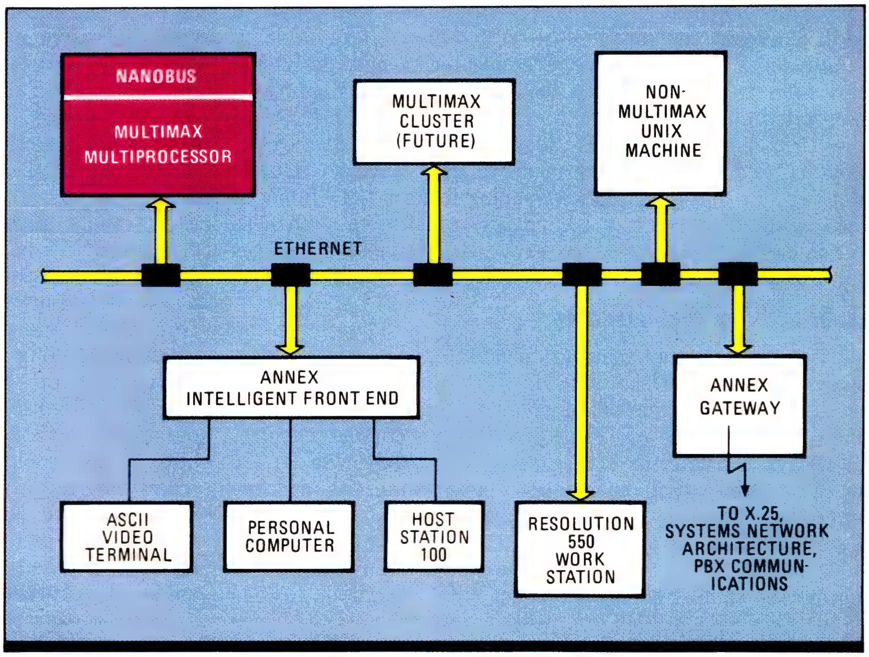
Other key features of the Multimax multiprocessor system include the very fast 100-megabyte/s Nanobus. Not only does the speed of the Nanobus allow a Multimax system to be expanded to the maximum number of 0.75-mips processors, but there is performance to spare—enough to handle the interprocessor traffic of even much faster processors in the future. In addition, an advanced cache-memory subsystem on each processor board efficiently interfaces the two processors on each board to the Nanobus and the large common memory, keeping bus traffic to a minimum and maximizing processor performance as it matches that performance to the speed of the common memory.

To keep the multiprocessors from having to worry about the details of outside communication with disk drives, work stations, and tape drives, the Multimax designers developed a board that contains both an Ethernet local-network interface and a mass-storage-device controller. A single system controller card acts as the communications clearinghouse, bus coordinator, and diagnostic center for Multimax. For basic operating software, users can choose between the two most popular versions of Unix, which have been extended for multiprocessor operation.

One of the big advantages of such multiprocessor computers is expandability over a wide performance range. Expansion is a matter of adding more central processing units and memory as needed, in contrast to a traditional computer product line where each model, from the smallest to the largest, is implemented with different technology and architecture. Moreover, if a multiprocessor computer itself is designed with long-term expansion in mind (by making the common bus fast enough to begin with, for example), the basic architecture can be extended indefinitely by plugging in successive generations of ever-more-powerful microprocessors and denser, faster memory chips. Also, improvements to cache memory will allow more CPUs to be added before the common-bus capacity is used up.

Encore will formally introduce Multimax next week at the Federal Computer Conference in Washington [*Electronics*, July 8, 1985, p. 18]. The Multimax multiprocessor, a significant development in its own right, is but one part—albeit a key one—in a whole computing environment: a collection of computing services and resources. The Encore Computing Continuum has three main characteristics: tightly coupled symmetrical multiprocessing, expandability to many processors, and distributed, intelligent control of peripherals.

The Continuum provides a set of multiprocessing and distributed-computing services that puts computing resources where they are most needed. In addition to Multimax multiprocessors, it can accommodate future clusters of Multimaxes, Annex network input/output computers, and Annex gateway computers to connect with other computer systems, work stations, and terminals (Fig. 1). Annex is a proprietary Encore-designed communications computer that serves as a basis for building either networks or gateways to other networks. Also part of the Continuum concept is a software environment that offers a choice of operating systems plus a wide range of applications and system tools.


NANOBUS
MULTIMAX MULTIPROCESSOR
MULTIMAX CLUSTER (FUTURE)
NON-MULTIMAX UNIX MACHINE
ETHERNET
ANNEX INTELLIGENT FRONT END
ANNEX GATEWAY
ASCII VIDEO TERMINAL
PERSONAL COMPUTER
HOST STATION 100
RESOLUTION 550 WORK STATION
TO X.25, SYSTEMS NETWORK ARCHITECTURE, PBX COMMUNICATIONS

1. EXTENDABLE. The Encore Computing Continuum is an extendable architecture of computing and communications resources. An Ethernet links work stations, intelligent front ends and communications gateways, and other Unix machines.

Central to the Multimax architecture (Fig. 2) is the tight coupling of its microprocessors. Tight coupling means that the processors and I/O devices share main memory, a common bus, and just one copy of the operating system. This tight coupling distinguishes the Multimax from closely coupled designs, in which each processor runs in a closed computing environment consisting of the processor, private memory, an I/O interface, and a separate copy of the operating system. The efficient sharing of all main memory and the operating-system resources delivers maximum use of available processors with a minimum waste of memory and bus bandwidth, because shared access to resources minimizes data copying and context switching. All this means that any processor can be used at any time for any job.

Multimax's speed and flexibility come from the Nanobus

SPEEDY NANOBUS

The Nanobus, the core of the Multimax architecture, is so named because its system backplane is 1 ft long—roughly the distance light travels in 1 ns. The system's performance and flexibility derive from the extremely high transfer speed of the Nanobus. As a result, Multimax systems can handle brief bursts of interrupts up to the staggering level of 1 million/s. Each processor can process steady streams of about 40,000 interrupts/s, 5 to 10 times the real-time interrupt-processing power of superminicomputers.

The separate address and data-transfer buses within the Nanobus can each transport 64 bits of new information every 80 ns, even if previous transmissions are still in progress. The result is a data-transfer rate of 100 megabytes/s. The arbitration scheme of the Nanobus, which is optimized for multiprocessing, guarantees that all system elements have fair access to it, even over short time intervals.

The memory bandwidth was designed to match the speed of the bus. The memory subsystem is interleaved eight ways so that a different memory bank stores each byte of a 64-bit double word; all 8 bytes can be accessed in one memory cycle. This moves data among processors, I/O devices, and memory at full bus speed.

The Encore designers did not want Multimax's design to be too restrictive. As a result, most types of microprocessors will connect to the Nanobus, and the bus's large bandwidth will accommodate future microprocessors with much higher performance.

System capacity and processing power increase linearly as additional processors and memory units are added. The minimum memory size for a system is 4 megabytes. The Nanobus provides eight slots for shared 4-megabyte memory cards, and so the maximum memory capacity is 32 megabytes. But this maximum capacity will grow as memory and packaging technologies improve. Because the Nanobus has 32-bit addresses, Multimax could address up to 4 gigabytes of memory in the future.

The 20-slot backplane in the Multimax cabinet supports three types of Nanobus cards: a system-control card (1 slot), shared-memory cards (8 slots), and bus-requester cards (11 slots). The 11 bus-requester cards in a full system may be any mixture of dual-processor cards and Ethernet and mass-storage cards, as long as there is at least one dual-processor card.

There are two basic types of bus-design problems: bus contention and priority arbitration. The first results when multiple devices simultaneously send or receive information along the same pathways; the second is ensuring that all devices get bus access efficiently and equitably.

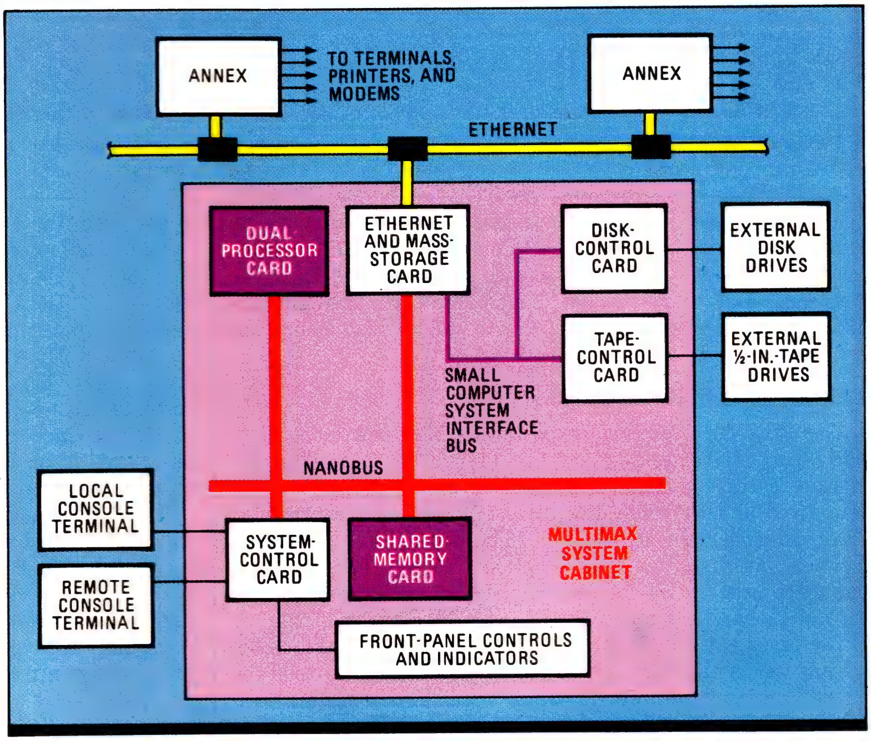
Certain characteristics of the Nanobus reduce these bus-contention problems. The high-speed 12.5-MHz bus clock moves bits so quickly that there is little time for contention, and the bus is separated into address (36 bits), data (72 bits), vector (a 14-bit pathway for interrupt vectors), and control sections. Although these pathways reduce the likelihood of bus contention, they do not eliminate it. So the Multimax system-control card takes care of priority contention, ensuring fair access to system resources for all requesters.

The designers of the Multimax system processor card found room for two 10-MHz NS32032 processors and two memory-management units on each card. There is also a 32-K-byte cache on each dual-processor card (Fig. 3).

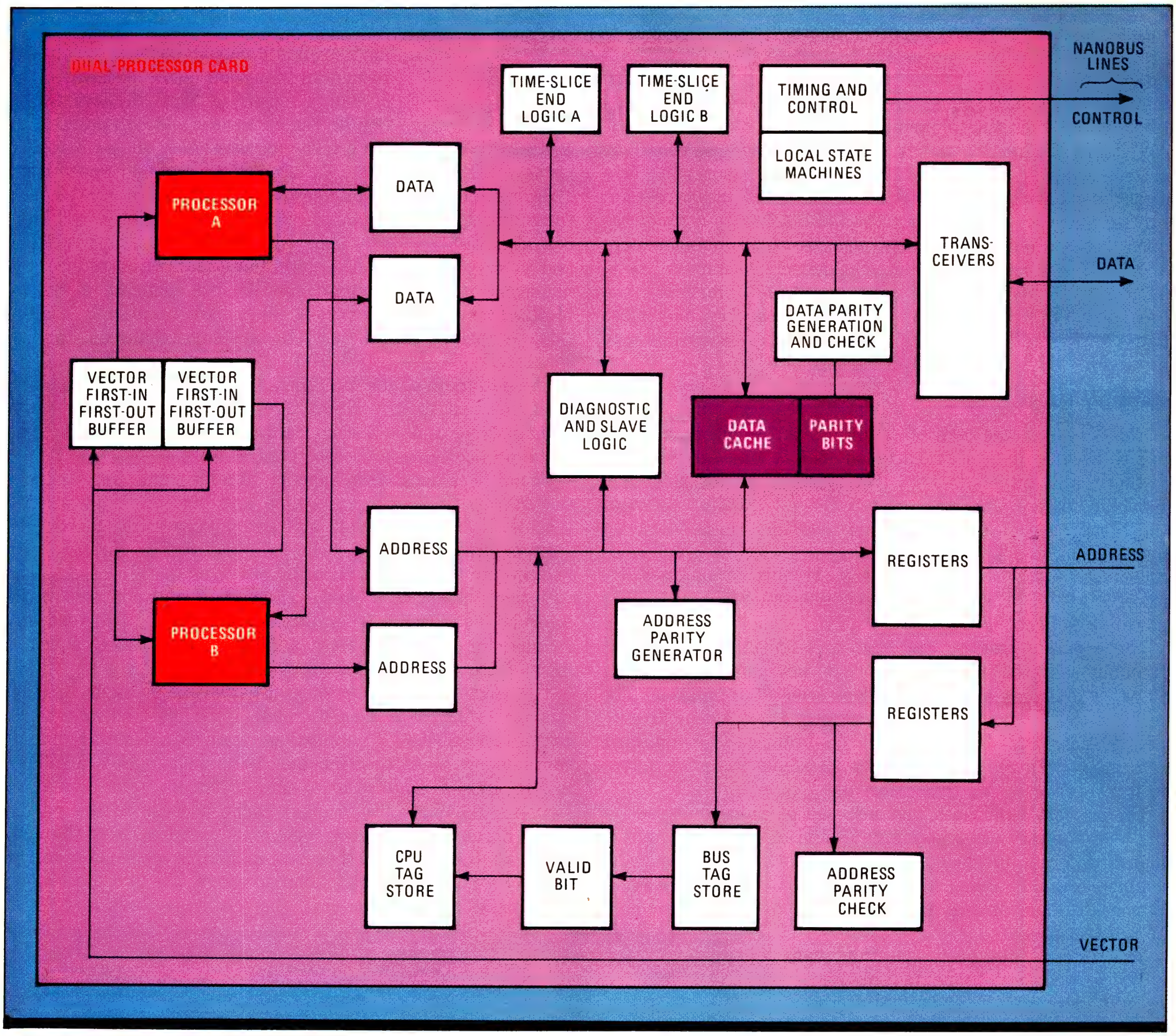
Cache decreases main-memory accesses and thus reduces the average memory-access time and bus traffic by storing frequently referenced data and instructions in the fast cache. Data is written into the cache from memory on the first read and on any subsequent write by either of the processors. The CPU tag memory array keeps an index of the addresses of the information in cache. Thereafter, the computer will read any request for data with these addresses from cache, which is much faster than reading from main memory.

The cache is kept current with relevant changes in main memory, which may be generated by writes from other processors or devices. The bus tag logic handles this, and it continuously scans the Nanobus for memory writes involving locally cached addresses. When it detects such writes, it switches the valid bit for that cache address to the invalid state. Because the bus tag logic is independent from the CPU tag logic, the dual-processor card maintains cache concurrency without any slowdown of cache access by the two processors.

To handle communications, the Multimax designers devel-



2. FULL HOUSE. Besides a card containing two NS32032 microprocessors, a Multimax system cabinet contains the fast Nanobus common bus, the system control card, and shared-memory, and cards that both interface with Ethernet and control mass-storage devices.



3. TWO ON THE CARD. The Multimax dual-processor card contains a 32-K-byte cache along with all the cache-control logic. It also holds two 32032 microprocessors, each with a memory-management chip and a floating-point unit.

oped a controller card that provides interfaces to both an Ethernet network and the Small Computer System Interface bus that connects the Multimax with system peripherals. The Ethernet and mass-storage controller card contains an NS32032 microprocessor, a 32-K-byte read-only memory for program storage, and a 32-K-byte RAM.

TALKING TO THE OUTSIDE

The Ethernet interface supports one Ethernet transceiver port. The SCSI interface on the first Ethernet and mass-storage card in a system supports controllers for the first four fixed or removable disk drives. It also supports a tape-drive controller for up to four ½-in. tape units. Users can increase mass storage with additional cards, each of which has three primary blocks—a local-network controller, an SCSI control section, and the control section for the card itself.

The other critically important avenue for communications in a computer is software. Encore designers decided to base the entire Continuum on proven industry-standard operating software, and so they chose Bell Laboratories' Unix, which is rapidly becoming a standard for multiuser, multitasking systems. Although there is no single standard Unix, two variants are emerging as co-standards: System V from AT&T Co. and 4.2bsd from the University of California at Berkeley.

Encore offers enhancements of both versions as alternative operating systems for the Multimax [*Electronics*, Aug. 19, 1985, p. 17]. UMAX V and UMAX 4.2, modified for use with multiple processors, exploit the principal characteristics of the Continuum. UMAX is multithreaded, which means that it gives users' jobs running on different processors simultaneous access to operating-system services, and it lets multiple processors handle many device interrupts simultaneously. In this way, it achieves maximum concurrency of operation among users' jobs and processors.

Multithreading requires the locking of shared resources at critical times and the synchronization of processors that are scrambling for access to these shared resources. UMAX does it with a set of core primitives, and uses three basic mechanisms. Spin locks synchronize by executing tight instruction loops until an expected condition occurs. Semaphores accomplish synchronization by suspending a process until the resources it needs are available. And read/write locks—specialized semaphores—control access to data structures for a single writer or multiple readers. Read/write locks prohibit write access until all pending reads are completed and prohibit read access while any processor is writing. ☐

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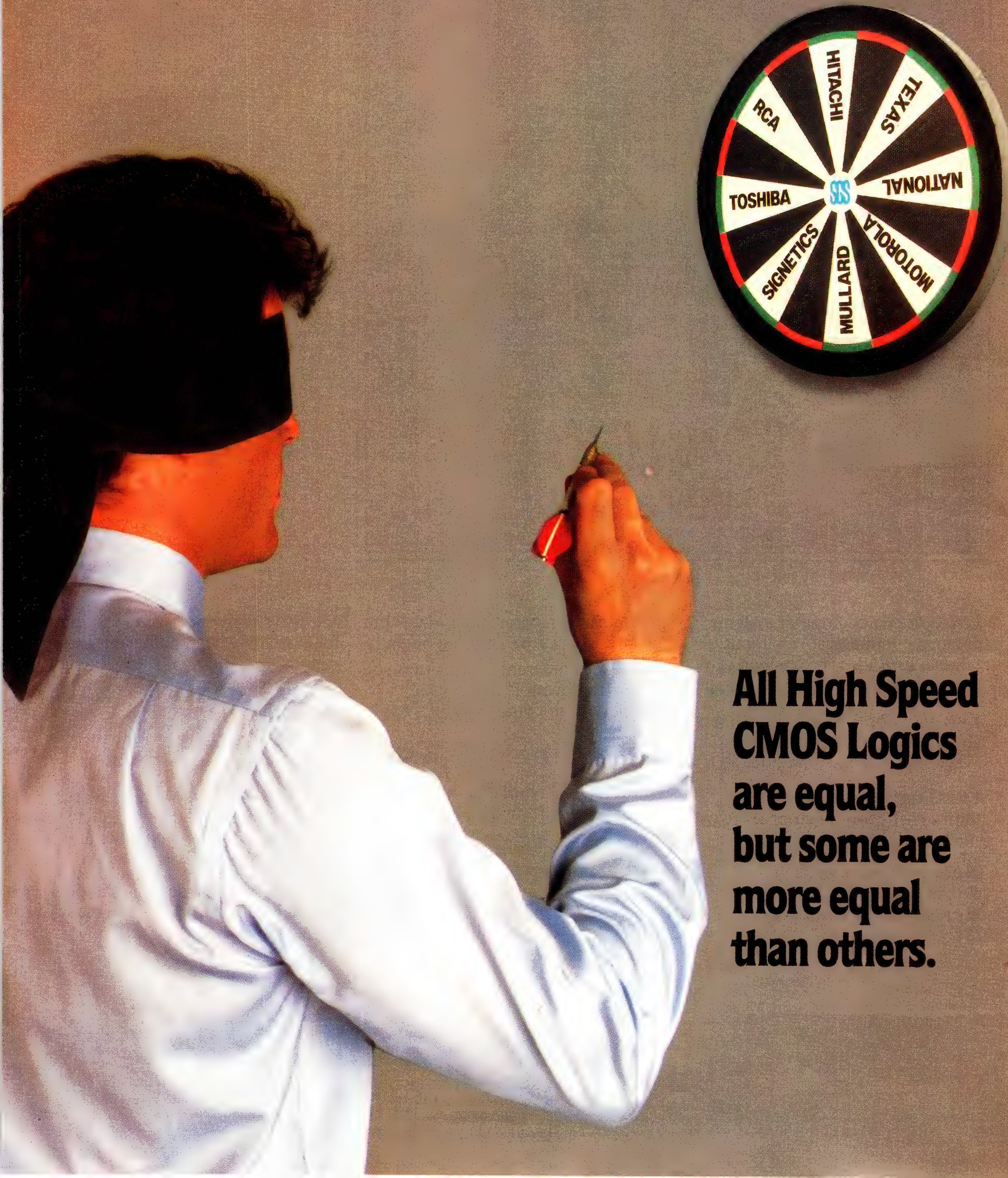

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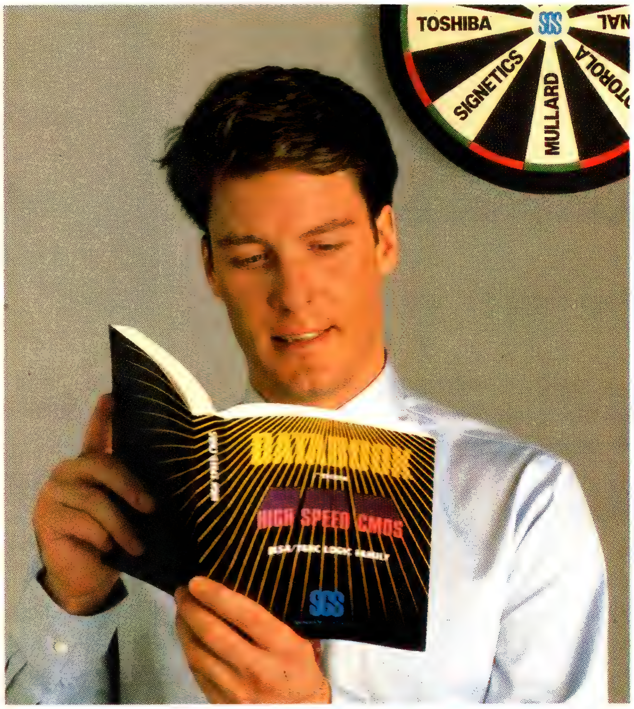

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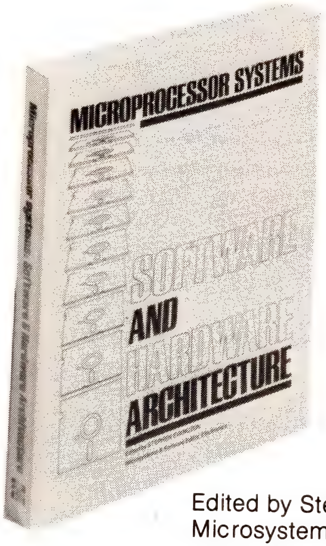

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PRODUCTS NEWSLETTER

SYSTEM INDUSTRIES PROVIDES CLUSTER SUPPORT FOR DEC'S MICROVAX II

When Digital Equipment Corp. introduced the Microvax II, it emphasized that it would not cluster the computer [*ElectronicsWeek,* May 27, 1985, p. 68]. So System Industries Inc. is doing the job instead. The Milpitas, Calif., company's cluster products include the 9900 cluster controller, the QDA/50 controller, the 9700 series disk-drive subsystems, and a disk cache processor. The 9900 connects to as many as eight central processing units as well as up to eight disk drives compatible with the storage-module-drive interface. The QDA/50 plugs directly into the Microvax Q-bus and, when used with System Industries' 9700 disk drives, comes in four configurations: the 9722, with up to four 120-megabyte spindles; the 9733, with up to four 240-megabyte spindles; the 9751, with up to four 380-megabyte spindles; and the 9798, with up to four 490-megabyte spindles. Prices range from $12,500 to $16,200. The disk cache processor, which works with all VAX computers, incorporates a proprietary algorithm for caching the most frequently and most recently used blocks of data, eliminating head movement for up to 95% of all disk input/output operations. Overall system disk-access time is less than 2 ms per hit. □

CONTROLLER COORDINATES EIGHT AXES OF MOTION FOR ROBOTS

Even sophisticated robots typically use only six axes of motion, but a Richmond, Calif., company specializing in motion control has developed a microprocessor-based eight-axis controller that sells for under $4,000. Unlike most multiaxis controllers, which are ganged single-axis devices, Berkeley Process Control Inc.'s BAM-8 handles all axes simultaneously. The controller contains a 16-bit microprocessor, 128-K bytes of RAM, and 128-K of ROM. The ROM contains motion algorithms and Protocol, a Forth-like process-control command language. In addition to robotics, the company sees applications in web-press processes and semiconductor manufacturing. □

VISIC'S HIERARCHICAL DRAM HAS STATIC RAM'S BENEFITS

Thanks to a hierarchical structure and a proprietary 1.5-μm HCMOS process, Visic Inc.'s 64-K hierarchical RAM (HRAM) combines the benefits of both static and dynamic RAMs. The San Jose, Calif., startup's V64H1 has three hierarchical modes of operation, which give it the speed characteristics of SRAMs. In random-access mode, the HRAM reads, writes, and cycles at 35 ns to any one of the 65,536 bits. The static-column mode allows a 25-ns read, write, and cycle to any of the 1,024 bits defined by the column addresses. In this mode, explains Peter Bagnall, senior vice president of marketing and sales, a designer has in essence 64 individual very fast 1-K RAMs. The third level of access is called SNAP, for static nibble access path, and provides a random read access of 4 bits in just 10 ns. Because the part is really a DRAM, it has a die size half that of a SRAM and uses just 100 μA on standby. Samples are available now for $107 each, but Visic expects prices to be competitive with SRAMs in the near future. □

CONVERTER LETS MACINTOSH COMPUTERS ACCESS IBM MAINFRAMES

A protocol-converter box that allows Apple Computer Inc.'s Macintosh to emulate an IBM Corp. 3278 terminal is hitting the streets. Avatar Technologies Inc.'s PA1000T works in conjunction with the Hopkinton, Mass., company's MacMainframe software and host file transfer to allow users to toggle between local Macintosh applications and remote 3278-terminal sessions with the mainframe. The PA1000T with MacMainframe costs $1,295 per Macintosh, while the host file transfer has a $500 one-time cost for all terminals. □

KEEPING COMPUTER DATA MOVING WITHOUT LOSING SATELLITE LINK

CONTROLLER MAKES DELAYS TRANSPARENT AT 2-Mb/s DATA RATE

Getting data from computer to computer when satellites play a role in the transmission is no small feat—especially when it's done at 2 Mb/s. But the Maxcomm/UB programmable communications controller from Talon Technology Corp. does it easily. It not only achieves those data rates but also performs encryption and corrects errors over extraterrestrial links and handles a wide range of protocols.

"With two satellite links, there is a lot of delay—about 1½ seconds in high-speed transmissions," says Paul M. Volk, Talon's director of engineering. "And many protocols have limits on the number of frames that can be transmitted without acknowledge-back signals."

If delays are too long, the link is lost. Maxcomm/UB's buffer memories allow information to continue to flow, making any delay transparent to the computer.

The Unibus-compatible communications coprocessor board, which is scheduled to be introduced at next week's Federal Computer Conference in Washington, is aimed at a range of data-communications applications involving long-distance computer transmissions that travel over two satellite links. The intelligent communications controller offloads transmission-management tasks from host computers, such as Digital Equipment Corp.'s VAXs and PDP-11s.

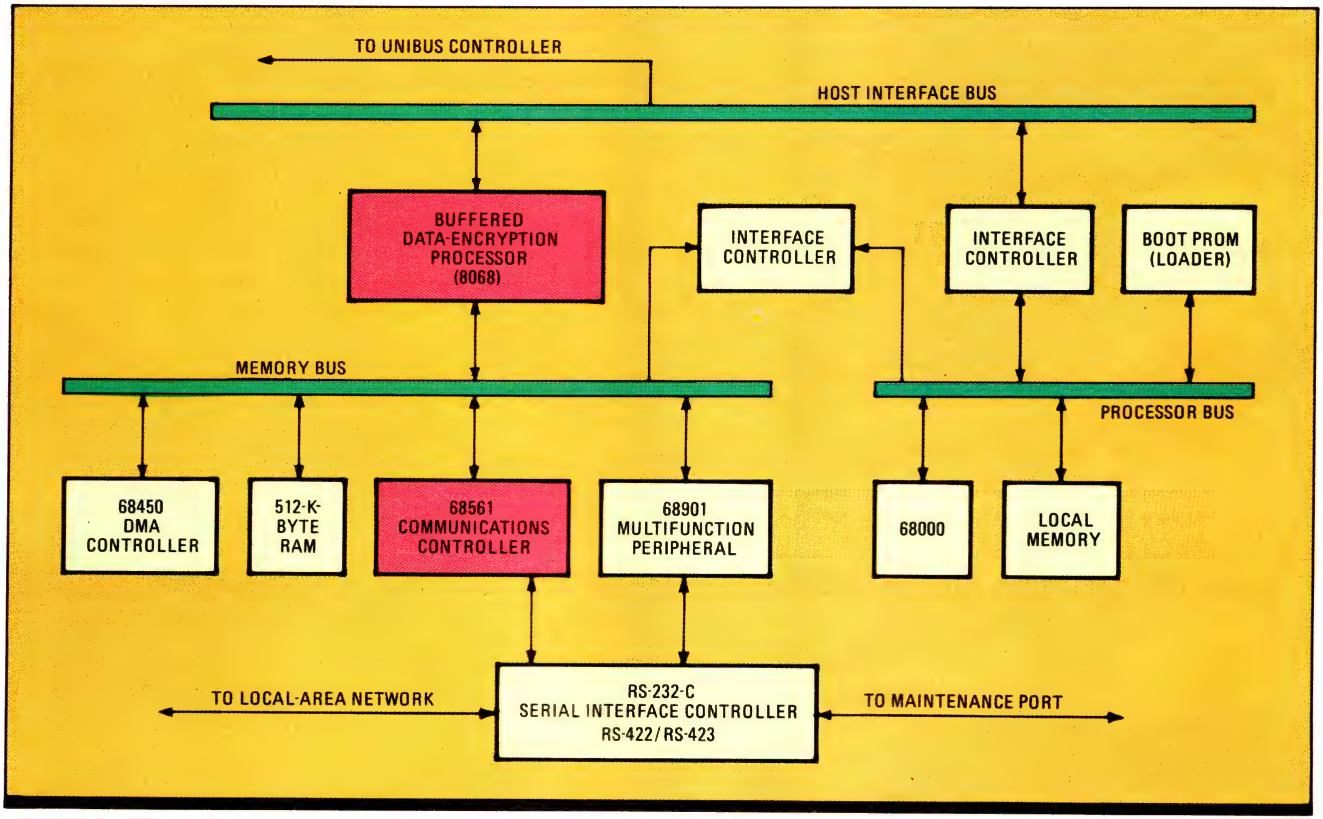
MANY PROTOCOLS. The Maxcomm/UB supports a number of standard data-communications protocols, including IBM Corp.'s Bisynchronous protocol and Synchronous Data Link Control, as well as High Level Data Link Control/Advanced Data Communications Control Procedures and HDLC/Link Access Procedure Balanced for X.25 applications. For long-distance communications, the board handles data transmissions with up to 127 outstanding frames under the HDLC protocol, for example. Frame sizes can range from 1- to 4-K bytes. The controller also supports Decnet local-network protocols.

The 68000-based Maxcomm/UB buffers outgoing and incoming data in 512-K bytes of RAM. The transmission buffer is expandable to 1 megabyte of RAM. In addition to using a 12.5-MHz Motorola 68000, Talon Technology is implementing a number of standard transmission schemes by using Rockwell International Corp.'s 68561 multiprotocol communications-controller circuit.

The Maxcomm/UB encrypts and decrypts data on the fly with an Advanced Micro Devices Inc. 8068 ciphering processor, second-sourced by Zilog Inc. The dedicated 8068 uses algorithms defined by National Bureau of Standards.

Talon implements direct memory access with a Hitachi Ltd. 68450 DMA controller, which provides four independent channels. A second 68450 may also be placed on the Maxcomm/UB for additional DMA channels, says Volk.

"The large buffer memory allows you to stay a step ahead of the game in the communications world," says Volk, referring to the use of 256-K dynamic RAM chips on the controller. Available data memory can be doubled to 1 megabyte by adding a second layer of 256-K DRAMs, which plug into piggyback dual in-line sockets on the controller.



HOPSCOTCH. The buffers on Talon's communications board keep data humming along in satellite-to-satellite hops so links are not lost.

With the standard 512-K bytes of memory, the Maxcomm/UB sells for $12,500 each. Beta-test site deliveries are scheduled to begin this month with production-volume shipments starting in December. Talon Technology marketing officials expect that the controller will be used for transmission on land-based and satellite links. The company is initially targeting government agencies, banks, and shipboard oil-search operations using minicomputers.

Communications protocols may be incorporated on the controller board as firmware in a PROM. The company will also configure the Unibus communications processing board to download protocols in RAM from the host central processor. The 68561 protocol chip performs a cyclical redundancy check on the transmitted serial bit stream for error detection and correction.

Data encryption, if implemented by the user, is performed on the fly from high-speed first-in, first-out buffers. "We do that to minimize the use of the computer's Unibus," says Volk. "We will burst several words into the FIFO, encrpyt, and then burst those words into communication memory on the board. It is an appropriate approach when encryption is needed, but you also have to get data on and off the communications controller quickly."

The hex-size Unibus board, which measures 15.7 by 8.4 in., contains one 50-pin header for communications and a 20-pin header for diagnostic and maintenance services. I/O connectors on the board include an RS-422/423 port, an RS-232-C port (for maintenance), and an International Telegraph and Telephone Consultative Committee V.35 interface.

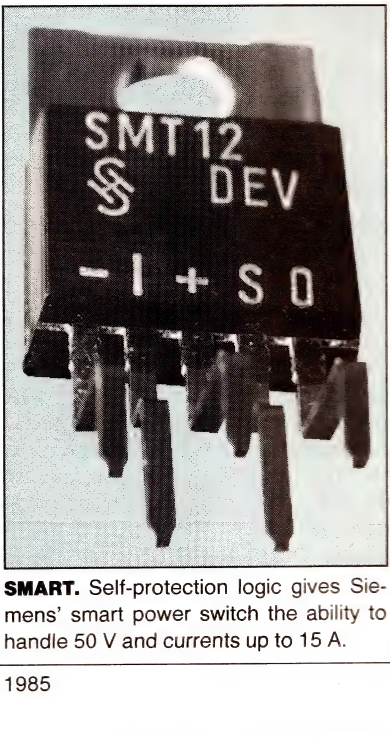
The unit automatically self-tests when powered up. Its power rating is 45 W maximum. The board requires input power supplies with ratings of +5 V at 8.5 A (maximum), +15 V at 75 mA, and –15 V at 15 mA. *–J. Robert Lineback*

Talon Technology Corp., 1819 Firman Dr., Suite 137, Richardson, Texas 75081. Phone (214) 680-9913 [Circle reader service number 338]

SIEMENS TO OFFER FIRST SMART POWER SWITCH

Smart power circuits are just now starting to come to market, and Siemens AG aims to be a leader with its Smart Sipmos technology. The first device to incorporate this design is about to be announced by the West German electronics giant. The SMT12 smart MOS power switch, which will operate over a wide voltage and current range, will use on-chip logic for protection. The low-cost switch, which connects between a high potential and the load, guards itself against overvoltages, short circuits, and temperatures in excess of 150°C. It is microprocessor compatible.

In case of a short, the SMT12 switches off current after just 40 µs. Should the load increase, an on-chip temperature sensor switches off the device when the junction temperature exceeds 150°C. Another safeguard is the 50-V overvoltage protection between the supply and the output. The output also has a 10-V zener-diode function that switches off inductive loads quickly.



SMART. Self-protection logic gives Siemens' smart power switch the ability to handle 50 V and currents up to 15 A.

In addition to the integrated protective functions, the SMT12 has a built-in diagnostic capability: it not only detects open loads, shorts, or excessively high loads at the output, it also reports such conditions through a status output. This output, on one of the component's five pins, also indicates undervoltage conditions. This is an especially important feature in automotive applications, the company points out.

The component's CMOS structure gives it a standby current requirement of less than 150 µA. This low value means that several SMT12s installed in a car, for example, will not appreciably drain the battery even when the car has not been used for a long time.

The part's operating range encompasses the 12- and 24-V battery voltages, another plus for auto applications. The SMT12 can switch lights, cooling fans, windshield wipers, and audio systems. Operating over a 6- to 50-V range and at 2.5 A continuous or 15 A maximum, the device is also designed for use in a wide range of measuring and control equipment—wherever high currents must be switched.

PUMPING VOLTAGE. High-side switching requires an auxiliary voltage that must be about 6 V higher than the supply. This voltage is generated by an integrated level converter (basically a high-voltage transformer) that pumps the gate-to-source voltage to the necessary level. In spite of the auxiliary voltage, which would tend to slow down the switching process, the SMT12 switches in less than 10 µs, making high-frequency applications possible.

What accounts for the SMT12's low cost—the introductory price is around $3—is the Smart Sipmos technology, which is based on a standard double ion-implanted MOS process. Reluctant to provide much detail on the proprietary process, Klaus Kaesen, marketing head for power semiconductors in Siemens's Components Group, indicates that the process does without complex junction isolation. The technology requires only a few masking steps; a simple base material, namely the usual MOS FET epitaxial material, will do.

The epitaxial layer integrates the low-resistance Sipmos output transistor and the 5-V CMOS logic circuits, as well as high-voltage (50-V) CMOS and bipolar structures with vertical power MOS FETs, without junction or dielectric isolation. Samples will be available in January, with volume production to begin in early 1987. *–John Gosch*

Siemens Components Inc., 800 Hoyt St., Broomfield, Colo. 80020.
Phone (303) 469-2161 [Circle 339]
Siemens AG, Components Group, Balanstrasse 73, D-8000 Munich 80, West Germany [Circle 340]

256-K DRAM HAS 4-BIT WORD WIDTH

Texas Instruments Inc. is taking the wraps off a new 256-K dynamic RAM this month that picks up the trend to 4-bit word widths that TI initiated in the 64-K generation. The new DRAM, called the TMS4464, delivers 256-K of read-write storage 4 bits at a time and is configured as 64-K by 4 bits.

The nibble-wide 4464, which TI calls ByFour, is pin-compatible with the company's three-year-old TMS4416, a 16-K-by-4-bit 64-K part. The ByFour chips conform to the pinout standards set by the Joint Electron Device Engineering Council.

The chip is fabricated from TI's scaled n-MOS, featuring double-level polysilicon-polycide gate structures. The process is identical to the one TI uses to manufacture its previously introduced 256-K-by-1-bit DRAMs.

The by-4-bit word width is an attractive design feature for designers of small microprocessor-based systems who need data in chunks of 8 and 16 bits at a time. For instance, with the 64-K-by-4-bit memory, system designers can implement 64-K bytes of main storage using only two 4464 chips. If conventional by-1-bit DRAMs were used, eight memories would be needed to provide byte-wide storage.

TI product managers say the ByFour DRAMs are attractive for use in such products as desktop personal computers, peripherals, robots, industrial control equipment, and engineering work stations.

The 18-pin 4464 operates from a single +5-V power supply with 10% tolerance. Typical power dissipation is 275 mW active and 12.5 mW standby. Its operating temperature ranges from 0°C to +70°C. Fully TTL-compatible, the 4464 latches all address and data lines on chip to ease equipment design.

TI is selling the 4464 in versions with three different access times. Chips featuring 120-ns maximum row-address and strobe-access times cost $8.80 each in 100-piece quantities. The 150-ns 4464 sells for $8 each, and 200-ns chips go for $6.40 each in orders of 100.

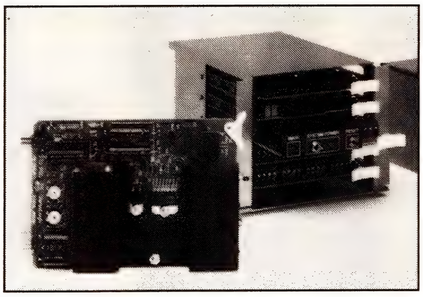
The 64-K-by-4-bit chip is currently available in 300-mil-wide plastic DIPs. Versions in surface-mountable J-leaded chip-carriers are expected to be available in the future. *–J. Robert Lineback*

Texas Instruments Inc., Semiconductor Group, Literature Response Center, P. O. Box 809066, Dallas, Texas 75380.
Phone (800) 232-3200 [Circle 341]

STD-BUS CARD HOLDS SWITCHING SUPPLY

The PSC card packs a high-efficiency switching power supply and battery-backup system on an STD-bus board that occupies a single ¾-in. slot. The plug-in supply provides 5 V at 3.5 A and ±12 V at 50 mA.

The supply's battery-backup capabilities include automatic glitch-free transfer from ac to battery power and charge circuitry for an external battery. In addition, a power-failure detection circuit senses the loss of ac power and immediately notifies the system processor by means of an interrupt signal.



The PSC card uses a 24-V ac input, which keeps potentially dangerous 120-V power out of the card cage, and allows the use of economical class II wiring.

Available immediately, the PSC card is priced at $248 each.

Versatile Logic Systems Corp., 87070 Dukhobar Rd., Eugene, Ore. 97402.
Phone (503) 485-8575 [Circle 380]

SMALL CASES HOUSE 1-W CONVERTERS

Packaged in cases that measure 1.2 by 0.5 by 0.3 in., the model 520 single-output and model 530 dual-output dc-to-dc converters provide 1 W for point-of-load power distribution in applications where space is a critical factor. Operating from power bus levels of 5 or 12 V dc, eight models are available that provide outputs of 5, 12, ±12, and ±15 V dc.

The converters can be mounted on the pc board directly at the point of load, which reduces decoupling and noise pick-up problems associated with longer power runs. Their operating temperature ranges from –25°C to +70°C.

Available four weeks after ordering, the converters range in price from $32.75 to $42 each in lots of 1 to 24 pieces.

Power General, 152 Will Dr., P. O. Box 189, Canton, Mass. 02021.
Phone (617) 828-6216 [Circle 381]

MEMORY DETECTS AND CORRECTS ERRORS

The MT9065, a memory module in a single in-line package, is built from one 256-K-by-1-bit and two 64-K-by-4-bit dynamic RAMs that share the substrate with four 0.2-μF capacitors. The RAMs perform error-correction coding; they detect and correct single-bit errors as the chip operates. The module operates from a 5-V power supply and draws 50 mW in standby mode. In operation, the MT9065 typically consumes 600 mW.

Two versions are available: the 64-K-word-by-9-bit MT9065 and the 64-K-word-by-8-bit MT8065. Both have an access time of 150 or 200 ns and are housed in a 30-pin leadless SIP.

The price for both models is $45 each in 100-piece sample quantities.

Micron Technology Inc., 2805 E. Columbia Rd., Boise, Idaho 83706.
Phone (208) 386-3900 [Circle 356]

SRAM RETAINS DATA ON 50 MICROAMPERES

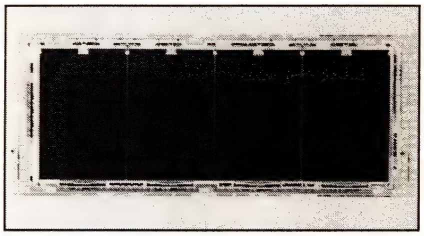
Fabricated using sub-2-μm design rules, the KM6264 8-K-by-8-bit CMOS static RAM features access times of 100, 120, and 150 ns. The low-power versions require 100 μA for standby mode and 50 μA to retain data. The memory is fully static—that is, it requires no external clocks—and allows asynchronous operation. The SRAM has one active high and one active low chip-enable state, a separate output enable, and three-state output buffers.

The KM6264, which is contained in a 28-pin plastic DIP, operates from a 4.5- or 5.5-V power supply and retains data at even 2-V levels. The company will ship samples of the KM6264 in early October, and production quantities will be ready at the end of that month. Prices were unavailable at press time.

Samsung Semiconductor Inc., 5150 Great America Pkwy., Santa Clara, Calif. 95054.
Phone (408) 980-1630 [Circle 354]

DYNAMIC RAMs HAVE 100-NS ACCESS TIME

A family of 1-Mb CMOS and n-MOS dynamic RAMs offers access times of 100 and 120 ns. These chips have been developed in four access modes. The 1-Mb n-MOS versions come in page mode and nibble mode; page mode offers random access and a data rate almost twice that of the standard-access mode, and nibble, a serial-access mode, provides a data rate about 25% faster than page mode. The CMOS chips, which offer a fast-page mode and static-column mode, consume power at the rate of only 60 (for the 100-ns part) or 50 mA (120-ns part). Their standby dissipation is 1 mA.



Multiplexed address inputs permit the chips to be housed in an 18-pin, 300-mil-wide DIP. Samples are available now. Prices are available from sales offices.

Toshiba America Inc., 2692 Dow Ave., Tustin, Calif. 92680.
Phone (714) 832-6300 [Circle 353]

256-K EPROM SELLS FOR LESS THAN $6

The 27256-20 256-K ultraviolet-erasable EPROM is fabricated in n-MOS technology and organized as 32-K words by 8 bits for an access time of 200 ns. The current requirement is 100 mA for active mode, 30 mA for standby. The chip operates from a 5-V power supply.

The 27256-20 is available now in production quantities of 10,000, for $5.78 each. Samples of a 150-ns version, the 27256, will be available in November.

General Instrument Corp., Microelectronics Division, 600 W. John St., Hicksville, N. Y. 11802. Phone (516) 733-3107 [Circle 355]

LOGIC ANALYZER SAMPLES AT 2 GHz

The 91HS8 logic analyzer improves the performance of the 9100 digital analysis system to a 2-GHz sampling rate, its manufacturer says.

Unlike other 9100 modules, which plug into the digital analysis system, the analyzer is a separate package. It is designed for analyzing, characterizing, and debugging high-speed digital systems and devices, including mainframe computer architectures, communications systems, and signal-processing systems. It works with both ECL and gallium arsenide ICs.

The system's resolution—less than 1 ns—rivals the timing resolution of a 100-MHz oscilloscope. In addition, it has high-performance probes, called podlets, with custom ICs at their tips; these podlets improve timing accuracy and signal fidelity. The probe's input capacitance is under 1 pF.

The 91HS8 triggers on a sequence of two words, or on one word when no second word appears after a specified period of time. Word recognizers are user-programmable for edge- or level-sensitive event recognition.

The self-calibrating unit minimizes channel-to-channel timing skew and probe-offset voltages. Delivery of the

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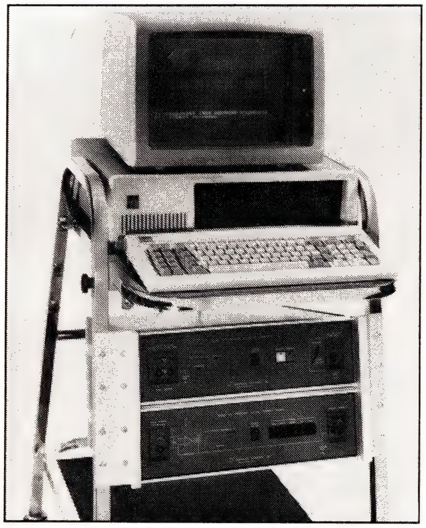
$25,000 module takes six weeks.

Tektronix Inc., Logic Analyzer Marketing, LAA-217, P. O. Box 12132, Portland, Ore. 97212. Phone (800) 245-2036; in Oregon, (503) 231-1220 [Circle 382]

CALIBRATOR COMES TO THE PRODUCTION LINE

The 7000 precision mobile-calibration system will help production lines that cannot afford to be shut down to send instruments out for a calibration check. The 7000 performs linear calibration of ac and dc voltage, current and resistance with resolution of 1 part per million within a voltage range of 100 nV to 1,200 V, a resistance range of 100 μΩ to 1,200 MΩ, and a current range of 100 nA to 20 A. The system provides calibration for such nonlinear functions as thermocoupling, resistance temperature detection, thermistor simulations, and dBm, rpm, and flow measurements.

The calibrator, its host computer, the current source, and a General Purpose Interface Bus with cables move along the line on a 24-in.-wide-by-34-in.-deep cart. The package, which includes a manual and software, is priced at $8,979.30. Delivery takes 30 days.



Shepherd Scientific Inc., 7100 Convoy Ct., San Diego, Calif. 92111.
Phone (619) 268-9696 [Circle 362]

KIT MAKES THE IBM PC A MULTIUSER SYSTEM

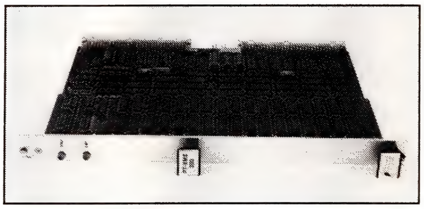
Occupying only one expansion slot, the Multiport expansion kit connects up to eight terminals to an IBM Corp. Personal Computer, PC/XT, or PC AT, transforming it into a multiuser system. The board contains either four or eight RS-232-C ports, an interrupt-identification register, and an optional software-protection circuit called Gardware. Multiport is compatible with most Unix-based operating systems, plus Pick and Multilink. It can also be used with networking software such as Easylan to build a low-cost serial network.

Shipments of Multiport have begun. It is priced at $495 for four ports and $735 for eight. Driver software for PC-DOS and Xenix is available for $25 and $50, respectively.

Arnet Controls Inc., 476 Woodycrest Ave., Nashville, Tenn. 37210.
Phone (615) 254-0646 [Circle 363]

MEMORY MODULE ACTS AS MAIL DROP

A dual-ported memory module, the PT-VME200, is aimed at multiprocessor systems, in which the module can serve as a mailbox for interprocessor communications. The PT-VME200, which is available on either the VMEbus or the VMXbus, also buffers data between parts of the system that operate at different baud rates.



Interleave and block-transfer modes are optional; in the interleave mode, the write cycle takes 260 ns. In the block mode, read-cycle time is as low as 340 ns, and data can be moved in 1,000-byte chunks before readdressing is required.

The VMEbus offers 32-bit data and address capability, while the VMXbus offers 32-bit data and 24-bit addressing. On-board generation of the parity bit protects the data's integrity.

Prices start at $1,500 per module, and units will be delivered in four weeks.

Performance Technologies Inc., 300 Main St., East Rochester, N. Y. 14445.
Phone (716) 586-6727 [Circle 364]

VME BOARD RELIEVES BUS TRAFFIC

The A68VME, a 68010-based single-board computer, supports all system functions without generating VMEbus traffic. The multiprocessor board uses four-level bus arbitration to manage traffic on the VMEbus and VMXbus, while a Small Computer Systems Interface bus peripheral controller keeps disk traffic off the VMEbus.

A combination mother-daughterboard, the CPU occupies one backplane slot; the daughterboard can be any of several optional communications modules. On-board RAM is 512-K bytes or, optionally, 1 megabyte; expanding memory on the VMXbus allows 10-MHz no-wait-state operation and mapping for up to 8 megabytes of RAM.

Two asynchronous serial communications ports, which are programmable to 19.2-kb/s, offer modem control. Hardware options that support the Manufacturing Automation Protocol for industrial applications are also available, and the processor is compatible with Regulus, a real-time distributed Unix operating system.

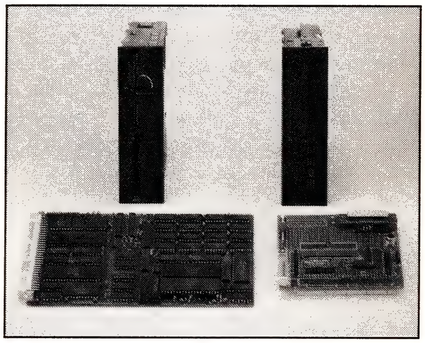
Available in 30 days, the board is priced from $2,850 to $3,950.

Alcyon Corp., 8716 Production Ave., San Diego, Calif. 92121.
Phone (619) 578-0860 [Circle 366]

BOARD COMPUTER CONTROLS HARD DISK

The Quark/300 microcomputer boasts an on-board disk controller that follows the industry-standard ST506 interface standard for hard-disk and floppy-disk drives. The controller makes possible various combinations of drives, including one four-head hard disk and two floppy disks or one two-head hard disk and three floppy disks. The proprietary hard-disk controller incorporates a 12-K-byte buffer that holds one complete track; data is transferred between the buffer and the hard disk at 5 Mb/s.

Other hardware on the board includes a 6-MHz Z80 processor, 128-K bytes or 256-K bytes of dynamic RAM, a video-display controller, and serial and parallel I/O interfaces. The software includes a license and utilities for the CP/M Plus operating system.



The price of the Eurocard-mounted Quark/300 is $595.

Megatel Computer Technologies, 2311 S. Anthony Blvd., Fort Wayne, Ind. 46803.
Phone (416) 745-7214 [Circle 365]

PERKIN-ELMER ADDS TO PARALLEL SYSTEMS

Perkin-Elmer has expanded its parallel-processing offerings with a system that tightly couples six independent processors. It has also introduced a single-processor system that is expanded easily.

COMPUTERS

The low-cost member in the 3200MPS family, the 3230MPS consists of a 3230XP CPU and up to five attached processors that can be individually focused on I/O operations or on computations. With up to 16 megabytes of memory, the system uses a shared memory bus that allows each processor to access memory and has up to two direct-memory-access channels. The basic 3230XP CPU is priced at $85,000; each additional processor adds $44,000 or $49,800 to the cost, depending on type.

The 3230XP 32-bit single-processor system uses a multibank memory system with a shared memory bus. The 3230XP is expandable to two DMA channels, each with data rates of up to 10 megabytes/s. It includes a 4-K-byte, 32-bit writable control store and a controller board that handles multiple peripherals. With 1 megabyte of memory, this expandable system is priced at $85,000.

Perkin-Elmer Corp., Data Systems Group, 2 Crescent Pl., Oceanport, N. J. 07757. Phone (800) 631-2154; in New Jersey, (201) 870-4712 [Circle 350]

IBM PC CLONE SELLS FOR $795

With no modifications, software written for the IBM Corp. Personal Computer and PC/XT runs 40% faster on the Turbo PC personal computer, the manufacturer says. The Turbo PC's microprocessor chip is an 8088-2, which offers dual clock speeds of 4.77 or 6.66 MHz.

The machine comes with 640-K bytes of memory on the motherboard, a 360-K-byte floppy-disk drive, a model 5151 keyboard, and a 135-W power supply. Eight expansion slots are standard.

Priced at $795, the Turbo PC is available from stock.

PC's Limited, 7801 N. Lamar St., Suite E-200, Austin, Texas 78752. Phone (512) 452-0323 [Circle 352]

IBM PC COMPATIBLE ALSO RUNS UNIX

The Challenger personal computer can run as a work station or communications terminal in a multiuser or cluster environment. With interface software, the Challenger can share file information with the 8300 series of Unix processors or with another Challenger. Other 8300 series communications options allow the Challenger to emulate an IBM Corp. 3278 display terminal.

The basic system of the Challenger contains five full-sized expansion slots and a ROM-based operating system that is functionally equivalent to that of the IBM Personal Computer. Memory consists of 256-K bytes of RAM and a 32-K-

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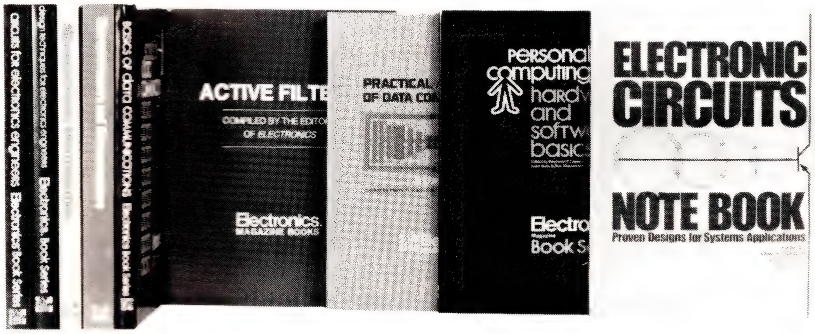
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This compilation of essential articles from *Data Communications* magazine includes chapters on terminals, acoustic couplers and modems, communications processors, networking, channel performance, data link controls, network diagnostics, interfaces, and regulations and policy. Pub. 1976, 303 pages, softcover.
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byte EPROM. The basic system also offers two serial ports, one parallel printer port, a speaker port, and a half-height dual-floppy-disk drive. A hard-disk drive is optional.

The company will start shipping units in September. The Challenger's retail price is $2,399, and there are discounts for original-equipment manufacturers.

Megadata Corp., 35 Orville Dr., Bohemia, N. Y. 11716.
Phone (516) 589-6800 [Circle 351]

40-PIN DIP HOLDS ACQUISITION SYSTEM

A 40-pin hybrid DIP houses a complete 8-channel, 12-bit data-acquisition system. The HS9404/9408, which measures 2.1 by 0.8 by 0.25 in. and weighs only 15 g, houses a multiplexer, an instrumentation amplifer, a sample-and-hold circuit, an analog-to-digital converter, and complete logic control.

The 9404 version features single-ended inputs, while the 9408 handles differential inputs. Both can be easily expanded to seven differential or 15 single-ended inputs.

A three-state output buffer provides easy interfacing with a microprocessor bus. Because the instrumentation amp has selectable gains ranging from 1 to 100, the engineer can use low-level signals in the range of ±100 mV to ±10 V.

The commercial versions of the parts are priced at $109 each, and military-grade versions go for $275 each, both in quantities of 100.

Hybrid Systems Corp., 22 Linnell Circle, Suburban Industrial Park, Billerica, Mass. 01821. Phone (617) 667-8700 [Circle 376]

DAC WORKS WITH 8-BIT PROCESSORS

The PM-7524 is an 8-bit buffered digital-to-analog converter that connects to all popular 8-bit microprocessors. It also features input latches and full four-quadrant multiplication. The converter is guaranteed to be monotonic over the full temperature range and does not require Schottky-protection diodes.

The company claims that its thin-film resistor processing provides ±⅛ least significant bit linearity and eliminates any laser trimming. A ±¼-LSB grade is also available.

Pricing ranges from $4.05 each for the ±¼-LSB commercial-grade part to $24.52 each for the ±⅛-LSB military version, all in quantities of 100. Delivery is from stock.

Precision Monolithics Inc., 1500 Space Park Dr., P. O. Box 58020, Santa Clara, Calif. 95052.
Phone (408) 727-9222 [Circle 378]

10-BIT CHIP CONVERTS IN 30 MICROSECONDS

The monolithic AD575 needs no external components or control signals to perform a complete 10-bit analog-to-digital conversion in 30 μs. Housed in a 14-pin DIP, the converter has a serial output that makes it compatible with many microprocessors. The serial output also allows simple interfacing in systems that require digital signal isolation: it needs only one optical coupler, compared with 10 units for parallel-output ADCs.

Accuracies for standard and higher-grade versions are guaranteed from 0°C to +70°C and −55°C to +125°C, at ±1 least significant bit and ±½ LSB, respectively. Pricing starts at $12.95 each in lots of 100.

Analog Devices Inc., Literature Center, 70 Shawmut Rd., Canton, Mass. 02021.
Phone (617) 935-5565 [Circle 377]

CONTROL STATION MONITORS 38 TASKS

The model 100 operator's interface station performs two-way communications with a programmable controller installed in a factory-floor process. By using the station's function keys, the operator can initiate up to 38 operations from the front panel; from the programmable controller, the station can receive and display up to 153 messages to the operator, in a number of data formats.

The process engineer can edit the entire data base of the programmable controller, subject to set levels of protection.

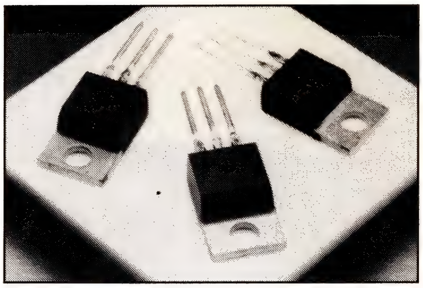
Typical applications for the model 100 include displaying status and alarm messages; displaying operator prompts for machine setup or fault recovery; and entering production-control data.

Prices were unavailable.

Ibis Industrial Products, 5545 Wilson Mills Rd., Highland Heights, Ohio 44143.
Phone (216) 461-0245 [Circle 367]

SWITCH DELIVERS 1.5 A IN 50 NS

The 100-V Fetlington model 2N7014 switch delivers 1.5 A from a logic signal of at least 4.5 V. The device's turn-on time is less than 50 ns. Capable of 20 W of power dissipation, the 2N7014 is rated for junction temperatures to 150°C.



Its applications include medium-power relays, lamps, and mechanical devices that are controlled by a logic signal but require a reasonable amount of current and voltage. The switch eliminates interface drives and, because it reduces the number of components required, it increases the reliability of the circuit.

Housed in a TO-220 package, the 2N7014 is priced at 93¢ in 1,000-piece quantities. Delivery is from stock.

Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. 95054.
Phone (408) 988-8000 [Circle 368]

OPERATIONAL AMP HANDLES ±22 V

Though specified at ±15 V, the model LH0101 operational amplifier operates at up to ±22 V, the manufacturer says. Peak output current is 5 A. Applications include dc and ac servo amplifiers, deflection-yoke drivers, programmable power supplies, and disk-head-positioning amplifiers. The ac specifications of the LH0101 include a power bandwidth of 300 kHz, small-signal bandwidth of 5 MHz, and a large-signal settling time of 2 μs to 0.01%.

The LH0101 op amp is available in four grades and in temperature ranges of either −55°C to +125°C or −25°C to +85°C. All grades are 100% burned in at 150°C.

Housed in an 8-pin TO-3 hermetic package, with a suitable heat sink the component can dissipate 60 W. In hundreds, prices begin at $28.24 each; samples and production quantities are available now.

Maxim Integrated Products, 510 N. Pastoria Ave., Sunnyvale, Caif. 94086.
Phone (408) 737-7600 [Circle 369]

ROBOT CONTROLLER MOVES IN 12 AXES

The 8200R robot-control system boasts 12-axis, multigeometry movement-control capability, and with its transformation software guides robots in controlled-path motion in either world or hand coordinates, for complex arm geometries. It also interfaces with vision

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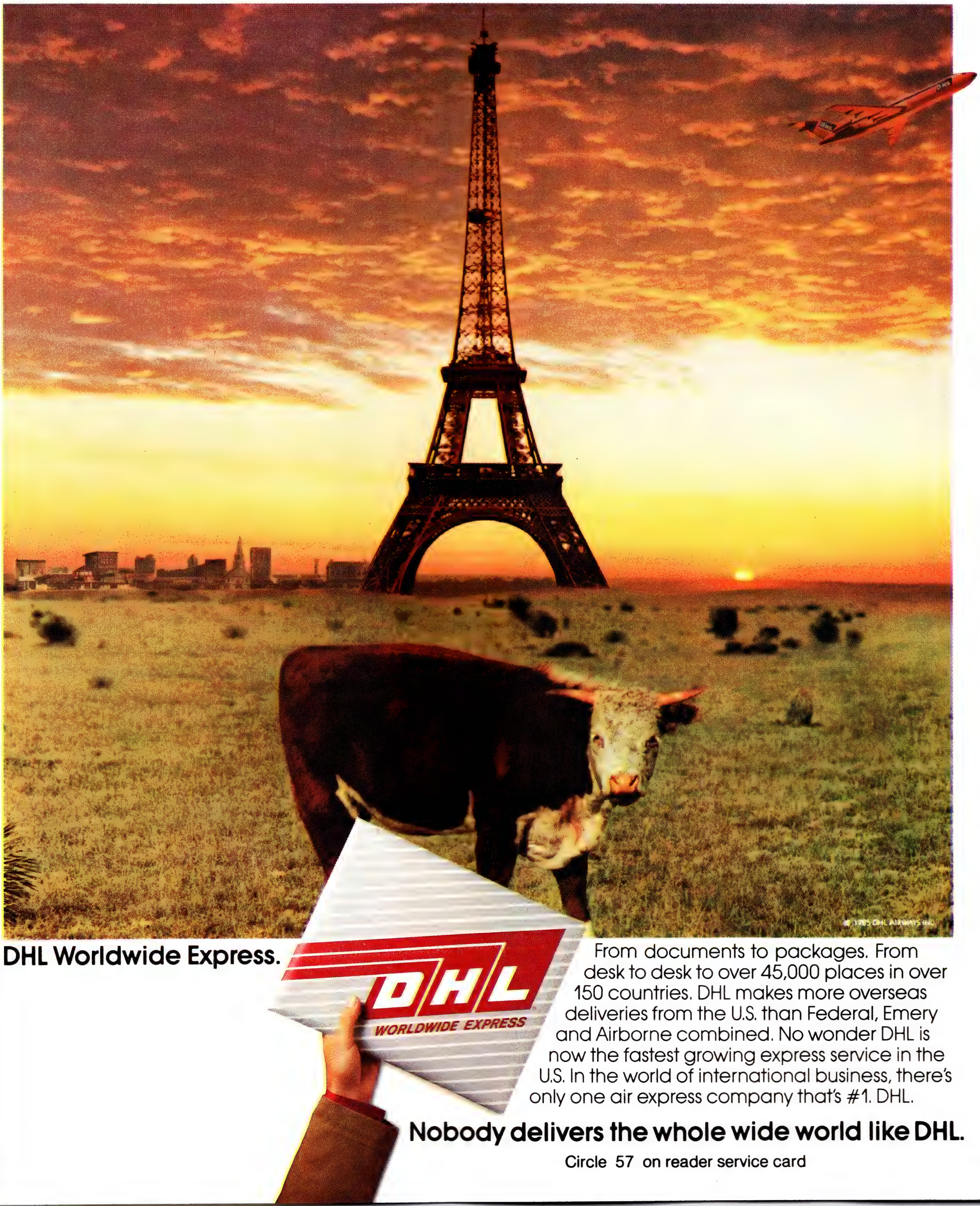

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systems and tactile sensors as well as to other controllers in a manufacturing cell. Thus it can be integrated into a wide range of applications as part of a manufacturing system ruled by a host computer.

A teaching pendant and a keyboard are provided for on-line programming. The control will also accept off-line programming from tape or a remote computer. Programmable application logic for interfacing the 8200R into a robot's work cell resides in the controller, speeding up development and troubleshooting of the robot system.

A communications interface with plant computers and the manufacturer's programmable controllers is optional. Another model, the 8400R control, is designed for positioning robots having up to six axes that perform low- to medium-complexity jobs.

The manufacturer will quote price and shipping time for both control models on request.

Allen-Bradley Co., Industrial Computer Group, 747 Alpha Dr., Highland Heights, Ohio 44143.
Phone (216) 449-6700 [Circle 370]

LASER PRINTER SELLS FOR $5,950

Aimed at the work-station market, three laser printers from Imagen all use the Canon CX printing subsystem and crank out eight pages a minute. The three models in the Imagestation line include the Executive, priced at $5,950; the Designer, priced at $6,400; and the Innovator, which goes for $7,200.

The Executive is intended for text and business graphics, the Designer for increased graphics support, and the Innovator for the most demanding graphics applications, such as computer-aided design and engineering.

Each printer includes Courier 8-, 10-, 12-, and 14-point typefaces, with 10- and 12-point bold, in all orientations: por-

trait, landscape, and inverted. Optional fonts, that can either reside on the host computer or in the printer, are available. Delivery of the printers is from stock.

Imagen Corp., 2650 San Tomas Expressway, Santa Clara, Calif. 95052.
Phone (408) 986-9400 [Circle 374]

THERMAL PRINTER SELLS FOR $61

Priced at $61 in lots of 1,000 pieces, the DPU-40 thermal printer module measures 8¼ by 4½ by 2 in. The 40-column unit prints at approximately 24 characters/s, forming letters in a 5-by-7-dot matrix.

The DPU-40 uses 3.1-in.-wide standard heat-sensitive paper, and despite its small size, accommodates a 1½-in.-diameter roll. Characters are 0.1 by 0.05 in. and an on-board character generator produces the 96-character ASCII set.

The printer connects with computers over a Centronics-compatible parallel port. Delivery is from stock.

Seiko Instruments Inc., 2990 W. Lomita Blvd., Torrance, Calif. 90505.
Phone (213) 530-8777 [Circle 373]

UNIT PUTS VOICE, DATA ON TWISTED PAIR

The Span DX-2000 system enables telephone companies to provide multichannel, high-speed, error-free simultaneous voice and data communications services with no changes to existing voice-switching equipment and no rewiring. Applications that can take advantage of this mix of voice and data on one line include videotex, electronic banking, security and energy management, remote meter reading, computer communications for electronic mail and data-base systems, and point-of-sale terminals.

A multichannel, data-over-voice multiplexer is the heart of the Span DX-2000, which supports data communications at 19.2 kb/s and simultaneous voice transmission over a single twisted-pair wire. Two intermediate versions of the system suited for situations where a single data channel is required will be available in the fall.

Both the SP 901A and SP 901S will be capable of supporting data communication over a single channel at speeds up to 19.2 kb/s along with simultaneous voice transmission. These systems will support both asynchronous and synchronous transmissions.

Pricing and delivery information for the SP 901A and SP 901S were unavailable at press time.

Access Engineering Corp., 12345 Sunrise Valley Dr., Reston Va., 22091.
Phone (703) 476-1420 [Circle 375]

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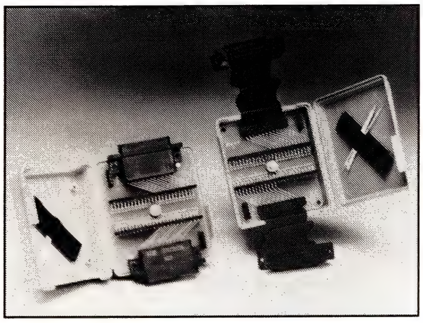


CABLE. With Easy Patch, a cable-reconfiguration product, technicians and engineers who need to quickly change an RS-232-C cable-pin configuration do not have to rebuild the cable. Thus a host computer can be connected quickly to a new peripheral, such as a printer, but keep the same cable. The pocket-sized unit readily fits into a toolkit. Available in two models—one with flush connectors and the other with dual-gender connectors—Easy Patch is stocked by distributors, with prices starting at $49.95.
Beckman Industrial Corp., 630 Puente St., Brea, Calif. 92621. Phone (714) 671-4800 [Circle reader service number 421]

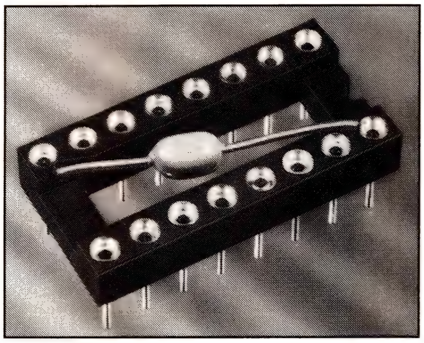
BLACK COATING. For engineers who need a broadband, absorptive coating for reflective surfaces in spectrometers and lasers, Darc transmits less than 1% of all light from near-ultraviolet to near-infrared. A non-carbon-filled coating, Darc can be patterned to 5-μm aperture geometries by means of a microlithographic process. The matrix used to create Darc is a heat-resistant polyimide.
Brewer Science Inc., P.O. Box GG, Rolla, Mo. 65401.
Phone (314) 364-0300 [Circle 422]

NICKEL SPHERES. Conductive nickel spheres can act as a low-cost alternative to silver in polymer thick-film ink, according to this manufacturer of specialty metallics. The nickel spheres, 8 to 10 μm in diameter, offer high compaction of nickel particulates within a binder system; they can be used alone or blended with silver and are treated to enhance their conductivity and environmental stability.
Novamet, 681 Lawlins Rd., Wyckoff, N. J. 07481. Phone (201) 891-7976 [Circle 423]

CHASSIS. A Multibus (IEEE-P796) chassis that combines a four-slot backplane, card cage, and 175-W switching power supply, the MC-604 system enclosure meets Federal Communications Commission Part 15 Class A requirements for resistance to electromagnetic and radio-frequency interference. The chassis, which is 3½ in. high, comes in front- and rear-loading versions. Card spacing is standard, and available backplanes include an iLBX bus. Unit prices are $1,295 for tabletop or $1,360 for rack-mount versions.
Electronic Solutions, 9255 Chesapeake Dr., San Diego, Calif. 92123.
Phone (800) 854-7086; in California, (800) 772-7086 [Circle 424]

FORM TRACTORS. A series of form tractors for printers that run in the range of 1,200 to 3,000 lines/min offers 6-, 8-, or 13-pin models. Each has all-metal needle bearings that create very low backlash and stand up to very rapid acceleration—mean time between failures exceeds 2,000 h. For original-equipment manufacturers, these standard form tractors can be modified, and a separate model number is assigned to large-volume orders to ensure repeatability in production.
Precision Handling Devices Inc., 617 Airport Rd., Fall River, Mass. 02720.
Phone (617) 679-5282 [Circle 425]

SOCKET. A Quiet Socket for 256-K dynamic-RAM chips relies on its integral capacitor to maintain a steady IC operating voltage, eliminating potentially harmful noise and soft errors at the chips' power source. Long leads that could increase circuit noise are also eliminated. The component used is a 0.33-μF 256-K Ramguard MLC decoupling capacitor. Quiet Socket comes with gold-plated beryllium copper spring contacts, and the body of the socket is glass-reinforced thermoplastic polyester. Available in spacings of 0.3, 0.4, and 0.6 in., the sockets can be specified in capacitive ratings from 0.01 to 0.33 μF at 50 V. Custom configurations can also be created.
Garry Electronics, 9 Queen Anne Ct., Langhorne, Pa. 19047.
Phone (215) 949-2300 [Circle 426]



EUROCARD. These triple-height Eurocards, measuring 11.4 by 11.0 in., contain 47 columns of 95 pins each on 0.3-in. centers. The board also contains two patterns of pins to house 68-pin grid arrays. Voltage and ground pins are located every inch on alternate rows, and decoupling capacitors can be added directly to these pins. The wire-wrap side of the board contains a total copper ground plane, while the component side has a similar collector supply voltage (dc) plane. The price of the triple-height Eurocard with a gold-tin body is $445; with a gold-gold body, $535. Delivery takes three weeks.
Interlogic Industries, 85 Marcus Dr., Melville, N. Y. 11747.
Phone (516) 420-8111 [Circle 428]

TUBING. Microminiature Teflon tubing, in sizes from 0.0015 up to 0.325 in. diameter, insulates conductors where board space is limited, thanks to its high dielectric strength. Available in extruded, heat-shrinkable, and slip-on configurations, Sub-Lite-Wall protects parts from moisture, abrasion, heat, and chemical damage. It is offered as a replacement for certain fluoroplastic dispersion coatings when used on solid or stranded wire. Samples of Sub-Lite-Wall are free.
Zeus Industrial Products Inc., P.O. Box 298, Raritan, N. J. 08869.
Phone (201) 526-0800 [Circle 427]

PIEZOELECTRICITY. Three organic piezoelectric materials—one flexible sheet and two films—create pressure transducers for such applications as blood-flow meters and sensitive audio equipment, or contactless switches in office equipment. PECM is a composite of polyacetal resin mixed with a polymer having high relative permittivity and piezoelectric ceramics powder; it is available as flexible sheets from 50 to 1,000 μm thick and as molding materials. PVDF, polyvinylidene fluoride, is a film from 1 to 150 μm thick, and P(VDCN/VAc), a film of vinylidene cyanide vinyl acetate copolymer, is available in thicknesses from 1 to 100 μm; it is recommended for temperatures over 100°C.
Mitsubishi Petrochemical Co. Ltd., Electronic Materials and Devices Dept., 520 Madison Ave., 17th floor, New York, N. Y. 10022. Phone (212) 980-9650 [Circle 429]

LABELS. Scantemp, a laminated pressure-sensitive label stock for pc boards, withstands direct immersion in wave solder, vapor-phase soldering, solvents, and other harsh temperature and chemical environments. Scantemp labels are designed for Scanmark formed-font impact printers equipped with a laminator; they can be custom designed to go on either the top or the bottom surface of the board. Printing meets Code 39 to USD-3, ANSI, and Logmars specifications, and other codes and label sizes are available.
Electroprint Inc., Scanmark Division, 150 Congress St., Keene, N. H. 03431.
Phone (603) 352-1130 [Circle 430]

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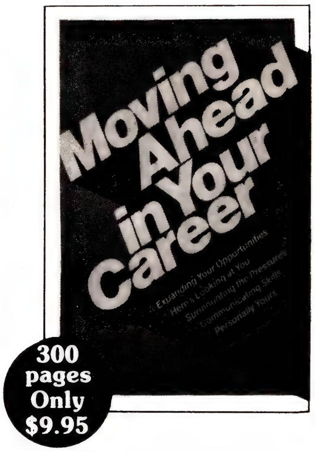

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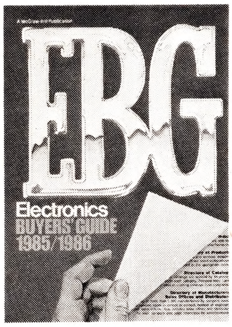

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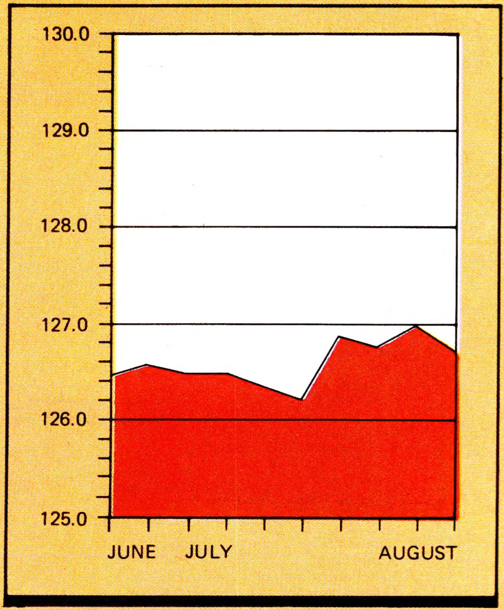
ELECTRONICS INDEX



THIS WEEK = 126.7
LAST WEEK = 127.0
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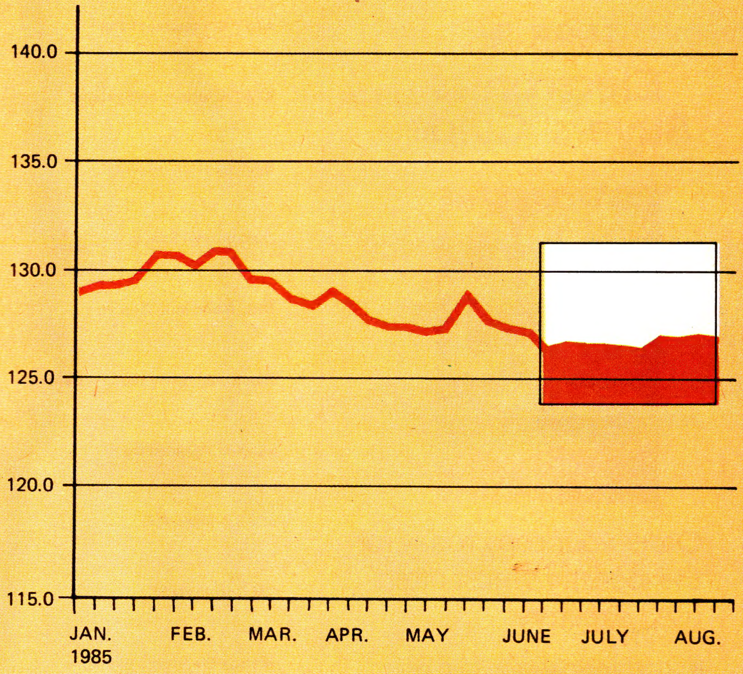

The *Electronics* Index, a seasonally adjusted measure of the U.S. electronics industry's health, is a weighted average of various indicators. Different indicators will appear from week to week.

U. S. GENERAL ECONOMIC INDICATORS

	July 1985	June 1985	July 1984
Average prime rate (%)	9.50	9.78	12.60
Retail sales ($ billions)	113.741	113.278	107.563
Unemployment rate (%)	7.2	7.2	7.3

U. S. ELECTRONICS PRODUCTION INDEX

	June 1985	May 1985	June 1984
Office and data-processing equipment	267.2	272.0	258.7
Communications equipment	220.8	220.5	200.4
Radio and TV equipment	148.9	144.2	147.8
Electronic and electrical instruments	139.4	138.9	138.0
Components	256.9	264.6	287.6

Cutbacks in the production of computers and components in June offset gains in the production of some types of electronic equipment. This drove the *Electronics* Index down 0.2% in the latest week. Equipment production had been weakening steadily since March, but June's overall 1.3% plunge was by far the steepest month-over-month fall in recent memory. Production of computers fell 1.8%, while output of components dropped 2.9%. Radio and TV makers saw their production jump 3.3%. Other categories of equipment racked up only marginal gains, however. Instrument makers boosted production by 0.3%, while production by communications-equipment makers inched up 0.1%.

Though the production of communications gear is up 10% over a year ago, this segment could deteriorate. AT&T Co., the largest U. S. producer of communications equipment, plans to cut 24,000 from its payrolls [*Electronics*, Aug. 26, 1985, p. 11]. This is an effort to trim some corporate fat in the face of heated market competition, but it also signals the effects of import penetration and the growing saturation of the market. For the last six months of 1984, production of communications equipment grew at an annual rate of 17.6%. For the first half of 1985, growth fell to an annual rate of 3.3%.

These figures notwithstanding, there are some signs that better times are on the way. The average prime interest rate, which hit 12.6% in July 1984, was down to 9.5% last month. Retail sales edged up 0.4% in July, and the unemployment rate stayed steady at 7.2%.

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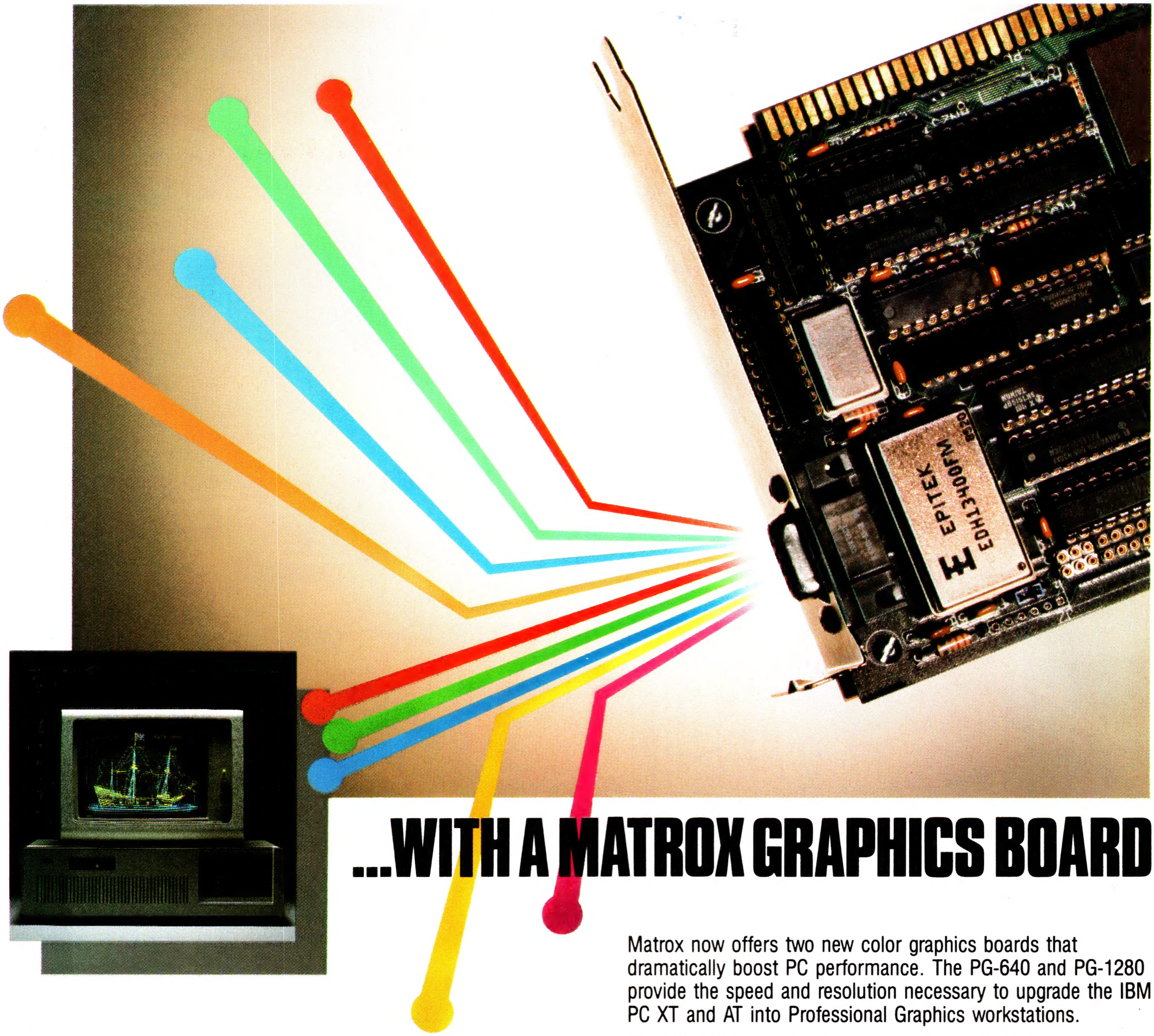

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